


# Removable Partial Dentures



## A Clinician's Guide



John D. Jones | Lily T. Garcia




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# Foreword

The examination, diagnosis, treatment planning, and clinical procedures related to treating patients with removable partial denture prostheses (RPDs) constitute the backbone of this new textbook directed toward the chairside practicing dentist. This current textbook co-edited by Drs. John D. Jones and Lily T. García expands, amplifies, and updates the basic prosthodontic principles found in my two earlier RPD textbooks, *Treatment of Partially Edentulous Patients* (L.J. Boucher and R.P. Renner, St. Louis: C.V. Mosby, 1982) and *Removable Partial Dentures* (R.P. Renner and L.J. Boucher, Chicago: Quintessence Publishing, 1987). It is with deep humility that I pay tribute to my colleague Dr. Louis J. Boucher for offering his insight, expertise, and prosthodontic knowledge in our two RPD textbooks.

This new "clinician's guide," with contributors who are faculty members, clinicians, and private practitioners, will serve as the bridge between the novice dental graduate and the experienced clinician as it relates to RPD practice. Its aim is to provide solid, fundamental prosthodontic principles applicable to modern dental practice such that the treating dentist can provide a sound, predictable, cost-effective removable partial denture in the real world of dental practice.

This text is significantly different from other RPD books in that it is very user-friendly in its layout, formatting, presentation style, and organization. While most RPD tomes heavily emphasize theory, this clinician's guide provides a decidedly more practical approach to RPD treatment. The chairside dentist will find practical and useful current information as to the state of the science and art of RPD treatment. I believe that this clinician's guide will be an essential RPD text for the practicing dentist, assisting in diagnosis, treatment options and modalities, and RPD problem solving.

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# Removable Partial Dentures

A Clinician's Guide

# 1 The Need for Removable Partial Prosthodontics

New treatment modalities, materials, and techniques have expanded both the dental literature and the prosthodontic treatment alternatives available to dentists and their patients. At the same time, analytic reviews of the dental literature have called into question the validity and efficacy of certain forms of traditional prosthodontic treatment. The development of new prosthodontic treatment procedures and materials, combined with the explosion in the volume of dental literature and the limited scientific basis for certain forms of traditional prosthodontic treatment, have vastly complicated the prosthodontic treatment planning. In this dynamic dental environment, evidence-based practice is emerging rapidly as the scientific foundation for prosthodontic treatment decisions. The techniques and materials presented are based on review of dental literature, as well as fundamental clinical principles for evidence-based practice, in an effort to help the general dentist provide quality patient care involving removable prosthodontics.

## Need for removable prosthodontic services

The incidence of natural tooth loss and the prevalence of edentulism were much higher in the United States prior to the 1960s, leading to a general consensus that the loss of natural teeth and consequent edentulism were perceived to be a normal part of aging. Over the past 50 years, tremendous emphasis has been placed on preventive dentistry and improving attitudes about the value of retaining natural teeth. The results of these efforts have been a significant improvement in oral health, a steady decline in the prevalence of natural tooth loss, and a reduction in the percentage of edentulous individuals in the United States.

There are three important aspects of oral health in the United States when considering current population trends that indicate a decline in natural tooth loss and edentulism. First, losing all of one's natural teeth is not an inevitable part of the human aging process. Second, there is continued growth in the percentage of the population that retains some of their natural teeth. And third, there is evidence of increasing chances for natural tooth retention for a lifetime for each successive generation.

Prior to 2002, there was informed speculation among dental educators that the need for removable prostheses will decrease markedly in the future. Over the last several decades of the twentieth century, there has been a steady decline in the prevalence of natural tooth loss and edentulism in the United States as the retention rates

for natural teeth continue to increase. Estimates based on national epidemiologic survey data indicate that edentulism has declined by 10% every decade. Many observers of these epidemiologic trends conclude that if edentulism and natural tooth loss continue to decline in the coming decades, the need for removable prosthodontic services will also decline. In contrast, other studies indicate that despite the declining percentage of edentulous individuals, the actual number of edentulous individuals and total market for prosthodontic services in the United States will increase because of aging trends in the population.

Douglass et al. published their analysis of epidemiologic data examining the combined effects of a decline in the percentage of edentulous adults in each age group and an increase in the number of older adults. When the number of adults in each specific age group was multiplied by the percentage that need a complete denture, the results suggest that the adult population in need of one or two complete dentures will increase from 33.6 million adults in 1991 to 37.9 million adults in 2020. The 10% decline in edentulism experienced each decade for the last 30 years will be more than offset by the 79% increase in the adult population older than 55 years. Despite an anticipated decline in the age-specific rates of edentulism, the effective demand and unmet need for complete dentures will continue to increase.

Douglass and Watson conducted an analysis of the epidemiologic data to project the future needs for removable partial dentures (RPDs) and fixed partial dentures (FPDs) in the United States. According to the National Health and Nutrition Examination Survey (NHANES) report of the average number of missing natural teeth among adults in 1971 through 1974 compared with the mean total number of natural teeth present among dentate adults in 1988 through 1991, it appears that U.S. adults retained approximately 1.5 more teeth per decade over these 20 years; this number may have increased by another 0.5 to 1.0 tooth during the 1990s. These results indicate that contrary to the well-documented decline in natural tooth loss in the United States, the need for RPDs and FPDs will actually increase as the population increases and ages.

The results of the Douglass and Watson analysis show a large and increasing amount of unmet prosthodontic need that will exceed the supply of prosthodontic services for the foreseeable 20-year future. Douglass and Watson project that the need for prosthodontic treatment will exceed the annual supply of prosthodontic services delivered by prosthodontists and general dentists in the years 2005, 2010, and 2020. Projected results indicate that total unmet fixed and removable partial denture need will increase from 488 million hours in 2005 to 517 million hours in 2010 and 560 million hours in 2020 (Table 1.1). Approximately 66% of this unmet need will be for fixed partial dentures and 34% of the unmeet need will be for removable partial dentures. Even if all active U.S. prosthodontists and general dentists devoted 100% of their clinical time exclusively to providing partial dentures, need would still not be met in 2005, 2010, or 2020.

Of great concern for every practicing dentist, as noted by Douglass and Watson, is the availability of dental laboratory technicians in the United States. The current number of educational programs in dental laboratory technology training is approximately one-half the number of educational programs that existed in 1980. If the dental profession is to continue to deliver high-quality prosthodontic services, and to have any hope of addressing the large and increasing

**Table 1.1.** Douglass and Watson's projected need for RPDs and FPDs in millions of chairside hours to deliver prosthodontic services for 2005, 2010, and 2020.

| | 2005 | 2010 | 2020 |
|---|---|---|---|
| Need for RPDs | 172.3 | 185.3 | 207.0 |
| + Need for FPDs | 363.1 | 378.2 | 402.5 |
| Total Needed | 535.4 | 563.5 | 609.4 |
| − Annual Supply | 46.7 | 47.8 | 49.2 |
| Unmet Need | 488.7 | 516.7 | 560.2 |

amount of unmet prosthodontic needs in the future, dental laboratory technology services will have to be improved and expanded. The quality of a prosthesis made by a qualified dental laboratory technician affects important aspects of a patient's oral health and function.

## Quality of removable prosthodontic services

Data from the Third National Health and Nutrition Examination Survey (NHANES III) provides the most current estimates of the prevalence and distribution of natural tooth loss and the use and quality of removable prostheses in the United States. This cross-sectional survey was conducted by the National Center for Health Statistics (NCHS) and the Centers for Disease Control and Prevention (CDC), in collaboration with a large consortium of federal agencies, including the National Institute of Dental Research (NIDR).

A report of prosthodontic findings from the first 3 years of the NHANES III by Redford et al. provides estimates of denture use among the U.S. civilian, non-institutionalized population 18–74 years of age, as well as information on the technical quality of dental prostheses nationwide. The prosthodontic findings represent new information on denture characteristics collected on a national probability sample via dental examinations on 7,374 individuals.

All NHANES III prosthodontic evaluations were performed by trained and calibrated dental examiners. The dental examiners noted the arch-specific presence or absence of a removable prosthesis by type and then evaluated the prosthesis for five quality characteristics: integrity; excessive wear of posterior denture teeth; the presence of temporary reline material, tissue conditioner, or denture adhesive; stability; and retention. All-resin removable partial dentures were excluded from the prosthodontic evaluations.

The oral examination sampling of 7,374 individuals yielded a population estimate of 166.5 million persons. Of the 7,374 examined individuals, 1,614 individuals presented with a prosthesis for evaluation, representing 35.7 million denture users 18–74 years of age. These findings indicate that about 1 in 5 persons 18–74 years of age wears a removable prosthesis of some type and about 1 in 7 wears a complete denture prosthesis. As expected, denture use increases significantly with age. Analysis of prosthodontic evaluation data indicates that approximately 60% of denture users have at least one problem with their prosthesis.

A report of the prosthodontic findings from the entire 6 years of the NHANES by Hummel et al. provides estimates of removable partial denture prevalence and quality within the U.S. non-institutionalized civilian population. Of the 17,884 patients over the age of 17 who had oral examinations, 1,306 or 7.3% wore one or more removable partial dentures (Table 1.2). Of the

**Table 1.2.** Perentage of removable partial dentures (RPDs) and complete dentures (CDs) by patient age group (n = 17,884 patients with NHANES III oral examinations).

| Age (years) | No RPD or CD | RPDs Only | | | RPDs with CDs | | CDs Only | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Man | Max | Both | Man RPD/ Max CD | Man RPD/ Man CD | Man | Max | Both |
| 17–30 | 26.7 | 0.04 | 0.15 | 0.03 | 0.01 | 0 | 0 | 0.04 | 0.02 |
| 31–40 | 17.2 | 0.12 | 0.49 | 0.10 | 0.07 | 0 | 0 | 0.33 | 0.19 |
| 41–50 | 11.0 | 0.22 | 0.60 | 0.26 | 0.18 | 0.01 | 0.02 | 0.63 | 0.52 |
| 51–60 | 6.5 | 0.25 | 0.71 | 0.45 | 0.51 | 0 | 0.03 | 0.86 | 1.13 |
| 61–70 | 7.2 | 0.34 | 0.66 | 0.60 | 0.65 | 0.04 | 0.04 | 0.89 | 2.23 |
| > 70 | 11.2 | 0.13 | 0.21 | 0.23 | 0.23 | 0.01 | 0.03 | 0.62 | 4.41 |
| Total | 80.7 | 1.10 | 2.81 | 1.68 | 1.66 | 0.06 | 0.12 | 3.38 | 8.49 |
| Total | 80.7 | | 5.59 | | 1.72 | | | 11.99 | |

1,303 patients with available dental examination information, 1,003 patients presented with a single removable partial denture and 300 patients presented with removable partial dentures in both the maxillary and mandibular arches.

Although previous national surveys recorded dental health status, NHANES III was the first national survey to evaluate thoroughly the problems associated with removable partial dentures. Hummel et al. evaluated the complete 6-year NHANES III data set (1988–1994) with respect to problems observed with removable partial denture prostheses. Approximately 65% of the 1,603 removable partial dentures examined had at least one problem, referred to as a defect (Table 1.3). The most common problem was lack of stability, identified for both maxillary and mandibular removable partial dentures with a single problem. Mandibular removable partial dentures significantly had more problems related to retention, whereas maxillary removable partial dentures significantly had more problems related to the presence of reline material and to integrity defects. Only one-third of the removable partial dentures were considered satisfactory according to the NHANES III evaluation criteria used to assess removable partial dentures (Table 1.4).

Analyzing data from the 6-year NHANES III, Hummel et al. reported a highly significant relationship between the age of the patient and type of removable prosthesis. The number of patients with removable partial dentures increased with age and peaked in the 51-to-60 years age group for maxillary removable partial dentures and the 61-to-70 years age group for mandibular removable partial dentures. In the oldest age group, greater than 70, the number of removable partial dentures dropped, and the number of maxillary and mandibular complete dentures increased. Although removable partial dentures are often associated with the elderly, the survey data indi-

**Table 1.3.** Number of defects reported by Hummel et al., when 811 maxillary and 792 mandibular RPDs were assessed for five criteria (integrity, tooth wear, the presence of temporary reline material or adhesive, stability, and retention) used in the NHANES III survey.

| Number of Defects | Number (%) of Maxillary RPDs | | Number (%) of Mandibular RPDs | |
|---|---|---|---|---|
| 0 | 194 | (23.9) | 341 | (43.1) |
| 1 | 333 | (41.1) | 213 | (26.9) |
| 2 | 150 | (18.5) | 142 | (17.9) |
| 3 | 99 | (12.2) | 69 | (8.7) |
| 4 | 33 | (4.1) | 26 | (3.3) |

**Table 1.4.** NHANES III evaluation criteria used to assess removable partial dentures.

| Type of Examination | Defect Category | Description of Defects |
|---|---|---|
| Extraoral | Integrity | Fractures, cracks, holes, or other defects in denture base materials.<br>Missing or chipped denture teeth.<br>Occlusal surfaces of posterior teeth missing.<br>Anterior tooth remnant does not cover denture base material.<br>Broken clasps, rests, or other portions of framework. |
| | Excessive wear of posterior denture teeth | Teeth lack occlusal anatomy.<br>Teeth are chipped. |
| Intraoral | Stability | Greater than or equal to 1 mm movement of occlusal rests or indirect retainers upon application of unilateral or bilateral force to denture base.<br>Movement (lifting of 1 mm) upon application of unilateral or bilateral force to stress-bearing areas. |
| | Retention | Denture dislodges when patient opens mouth moderately wide, but without strain. |

cated that at least 250,000 people under the age of 40 had removable partial dentures.

The findings of Hummel et al. clearly demonstrate a need to improve the quality of removable partial denture prosthodontics. The prevalence of defective removable partial dentures in the NHANES III population indicates the need for quality in the clinical procedures and in the dental laboratory fabrication techniques, as well as an increased awareness of postinsertion care. Specifically, Hummel et al. suggested the following recommendations: include the development and use of new or enhanced biomaterials that are easy to use, repair, and maintain; use simplified removable partial denture design and fabrication techniques to enable all dentists the ability to provide accurate, well-fitted removable partial dentures that are functional; and emphasize patient awareness and education about the need for postinsertion care for proper maintenance and care of removable partial denture prostheses and to ensure care includes replacement of a prosthesis when indicated as diagnosed by dentists for partially edentulous patients.

In summary, the published prosthodontic data from NHANES III provide clear indications that, despite increasing trends in natural tooth retention, dependence on removable prostheses is still a reality of life for millions of Americans. Removable partial dentures remain the most readily available and financially reasonable prosthodontic treatment alternative for the greatest number of partially edentulous patients. Furthermore, two-thirds of removable partial denture users need dental care to address one or more problems with their dentures.

Several recent clinical studies have also evaluated the quality of removable prosthodontic services. Zlataric and Celebic reported the results of their survey on patients' satisfaction with RPDs and a comparison between patient and prosthodontist assessments of the RPDs. The patients' assessments of their RPDs were high, with more than half of the patients grading their RPDs as excellent. On average, patient assessment of the treatment outcomes with RPDs was less critical than prosthodontist assessment. However, the few dissatisfied patients assessed their RPDs worse than did the prosthodontist. Another clinical study by Grundstrom et al. evaluated clasp-retained RPDs over 8 years of use. Of the 207 RPDs followed throughout the 8-year period, 132 or 63.8% were still in use, while 75 or 36.2% were not in use. The most common complications noted during the observation period were fractured clasps and loosened denture teeth. A third study by Yeung et al. evaluated cobalt-chromium RPDs 5 to 6 years after initial placement. While the status of the RPDs that had been used consistently was generally good, usage of the RPDs declined with time, and one-half of the RPDs had been discarded or replaced within 5 to 6 years of placement. The discarded RPDs had been in use for an average of 19.5 months. The main reason given by patients for not using the RPDs was general dissatisfaction with the dentures in various combinations of comfort, fit, and chewing ability.

Other recent clinical studies have evaluated the periodontal conditions of patients with RPDs. A retrospective study by Kern and Wagner looked at changes in the periodontal status of patients wearing different designs of RPDs for 10 years. When compared to baseline values at placement, they found a deterioration of the probing depths and mobility of the RPD abutment teeth. The abutment teeth of clasp-retained RPDs suffered more severe deterioration than the abutment teeth of conical crown-retained RPDs. Another clinical study by Zlataric et al. evaluated the periodontal health of 205 patients with 123 maxillary and 138 mandibular RPDs. Significant differences were found for the plaque, gingival, and calculus indexes as well as for probing depth, gingival recession, and tooth mobility between RPD abutment teeth and non-abutment teeth, with abutment teeth exhibiting more disease. The authors of these two clinical studies evaluating the periodontal health of RPD patients concluded that appropriate RPD design, good oral hygiene, and regular recall and maintenance intervals for RPD patients are important for controlling the occurrence of periodontal disease in RPD patients.

The dental literature indicates that in order to achieve the greatest benefit from removable partial denture treatment, the principles of preventive dentistry must be integrated into all aspects of patient care, including those patients who have had removable prosthodontic care. Patient education and motivation in maintaining acceptable oral hygiene are important factors in determining successful use of removable partial denture prostheses. Dentist education and philosophy for preserving individual teeth, roots, alveolar bone, and oral mucosa through the distribution of functional forces to remaining oral tissues according to intraoral limitations are also important factors in successful removable partial denture treatment.

## Summary

Contrary to the well-documented decline in natural tooth loss and edentulism in the United States, the need for removable partial dentures will actually increase. The substantial growth of the U.S. population, the extended life expectancy, and the fact that U.S. adults are retaining more of their natural teeth mean that a larger proportion of adults will be partially edentulous and require care to include the treatment option of removable partial dentures. Accordingly, practicing dentists will find that a sizeable minority of their adult patient population will continue to need removable partial denture services for decades to come.

Recent dental literature provides several important points regarding future trends in removable prosthodontic services. The unmet need for prosthodontic services will increase and exceed the supply of services available for the foreseeable future. Practicing dentists will encounter a patient population with needs for complete and removable partial denture prosthodontic services. Educational efforts should be strengthened to increase patient and dentist awareness of the need for postinsertion prosthesis care so that removable prostheses are properly maintained and replaced when indicated. Finally, dental education administrators should appreciate the continuing need for a diagnosis-based curriculum to include removable prosthodontic training in the dental curriculum for decades to come.

Prosthodontic treatment planning is a complex process that involves a combination of diagnostic information, patient desires, evidence-based outcome data, and a thorough review of all treatment alternatives. Clearly, removable partial dentures are, and will remain for decades to come, viable prosthodontic treatment alternatives for millions of partially edentulous patients. With appropriate skills and the availability of software to conduct a literature search, evidence-based practice is a powerful means for general dentists to establish the effectiveness of patient treatment decisions and to enhance clinical knowledge and skills over the course of a professional career.

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# 2 Diagnosis of the Partially Edentulous Patient

Careful planning by the dentist is a fundamental factor in successful prosthodontic treatment. For each dental patient, a unique treatment plan must be developed on the basis of an analysis of the patient's problems and needs. This analysis, ultimately the diagnosis, is made during the course of a number of examination procedures. Routine examination procedures commonly include an assessment of the patient's overall health status, medical history, dental history, intraoral and extraoral examinations, an analysis of the patient's radiographs, a study of the mounted diagnostic casts, and an inspection of any existing dental prostheses. In addition, an assessment of the patient's expectations is a critical part of the examination process.

Comprehensive treatment plans for partially edentulous patients are usually more complicated than treatment plans formulated for edentulous patients or for patients who do not require the replacement of missing teeth. A general assessment includes consideration of a number of questions:

**General Patient Assessment Questions to Consider**

1. Will this person's needs best be met with an implant-supported prosthesis, a fixed partial denture (FPD), a removable partial denture (RPD), a complete denture (CD), a combination of these treatments, or no prosthodontic treatment at all?
2. If an RPD is necessary, what will be the best design for it, or what design features must be incorporated to achieve the best possible function, comfort, and esthetics?
3. What additional dental treatment is indicated to restore the remaining dentition and the oral tissues to the best possible state of health, considering the patient's circumstances?
4. What special treatment is required to prepare the mouth for the acceptance of the prosthesis?
5. What is the most logical sequence of treatment to follow in accomplishing all of the planned procedures?

The answers to these questions may be derived in a logical and systematic manner. An orderly sequence of examination and diagnostic procedures is described in this chapter. The diagnostic significance of various examination findings is also discussed. The integration of this information into the development of a comprehensive treatment plan for a partially edentulous patient is presented and key elements of the Prosthodontic Diagnostic Index are introduced as a reference to emphasize *diagnosis first* as opposed to viewing a patient with emphasis on treatment.

## Examination procedures and diagnostic information

As with any dental patient, some time should be spent getting acquainted with the patient and reviewing the patient's personal data. Certain key items, such as the patient's age and occupation, often have diagnostic significance. For example, the patient's age gives the dentist a general indication of the patient's ability to adapt to wearing a prosthesis, as well as an indication of manual dexterity to manage maintenance and home hygiene procedures. General health, resistance to injury, and the healing response are also generally related to a person's age. Concerns about esthetics are as important to the success of a prosthesis as are the comfort and function for patients at any age. From the very beginning of the interview and examination processes, the patient may provide significant clues regarding his or her attitudes toward dental health and details of treatment. The dentist should be alert for this information and should note his or her impressions in the patient's clinical record as the interview proceeds.

In the examination, a dentist may ask, "How can I help you with your problem?" or "What concerns do you have about your situation?" Occasionally, patients will have very definite ideas about what they want, and it is important for the dentist to determine if their expectations are realistic. It is an extremely valuable practice for the dentist to record the patient's answers and key remarks as they are expressed.

## Dental history

It is essential that the dentist determine how the patient has accepted and adapted to past dental treatment. The reasons for the loss of the patient's missing teeth are significant and should be elicited by questioning. A history of severe dental caries raises suspicions of current as well as past neglect or nutritional problems. The extraction of teeth because of advanced periodontal disease not only suggests a history of neglect but also is predictive of continued alveolar bone or residual ridge reduction as a result of systemic factors. The loss of teeth as a result of traumatic injury or surgical excision of malignant tissue is important for the dentist to note. The side effects of trauma and surgery can also result in psychosocial issues, as well.

## Health and medical history

The patient's health and medical history are of great importance in making treatment decisions and predictions related to prognosis because of the dependent relationship of oral health to systemic health. Every dentist, like every physician, is required to be fully informed of the patient's physical and emotional condition before beginning treatment.

It is a common practice in many dental offices to have the patient fill out a comprehensive health questionnaire at the time of registration. Complete, reliable medical histories are sometimes not obtained without persistent questioning, since dental patients commonly do not relate general health status or medical problems to their dental treatment.

A comprehensive medical history may reveal problems for which the patient's physician should be consulted before a diagnosis is made and a treatment plan formulated. Chronic degenerative or dysfunctional diseases such as diabetes,

arthritis, obesity, hypertension, and osteoporosis usually compromise treatment results. The limitations to success imposed by these conditions must be explained to the patient when the treatment plan is presented.

### *Medication history*

Many medications, both over-the-counter and prescription drugs, that patients use can adversely affect the oral tissues. It is imperative for the dentist to record the patient's medication regimen to include over-the-counter vitamins and therapeutic agents, in addition to prescription medications. The numbers of pharmacotherapeutics that one patient may be taking can be complicated, but the use of electronic medical references such as Lexi-Comp (Lexi-Comp, Inc., Hudson, OH), an on-line drug information system, can help the practitioner evaluate side effects and compounding effects of multiple medications. In addition to current standards of practice by the pharmacist, the dentist needs to help the patient understand the side effects as they pertain to success or failure of comprehensive dental treatment. For instance, in the event the patient must take antisialogues, the decreased salivary flow will compromise a patient who may be in a high-caries risk category compounded by use of a removable prosthesis. This type of patient will require a change to the hygiene maintenance and recall schedule, additional prevention education, and additional use of fluoride therapy on a prescribed, regimented basis.

### *Dietary patterns*

A patient's dental and general health problems are often complicated by nutritional inadequacies, and vice versa—nutritional inadequacies can be compounded by poor oral health and its effect on proper nutritional intake by the patient. Any significant variation from a normal, balanced nutritional intake signifies the need for a more definitive dietary evaluation.

## Subjective evaluations

During the course of the preliminary interview and during recording of the medical and dental histories, an observant dentist will make valuable subjective evaluations of the patient's physical condition, muscular control, manual dexterity, facial expressions and tooth display, speech patterns, mental capacities, and dental knowledge. The treatment record should be limited to the diagnosis, treatment plans, treatment provided, progress and prognosis, consultation requests and reports, and reactions of the patient. Copies of laboratory work authorizations and medication prescriptions and administration also should be included in the record. Relevant conversations with the patient and other health providers should be noted in the record, in a professional manner.

The evolution of the electronic medical record should enhance the capability of detailed notes versus illegible, written notes for reference, but as with any type of record, comments should be on a professional basis since patient privacy and security of all information are in the best interests of the patient and in providing the best quality of care.

## Medical consultations

Dentists must assume responsibility for recognizing medical problems that require the attention of a physician when these conditions manifest in the mouth. A number of systemic diseases, including diabetes, anemia, osteoporosis, and gastrointestinal disorders, may exhibit signs and symptoms in the oral tissues. If signs suggestive of systemic problems are detected during the oral examination, a consultation with the patient's physician should be obtained. When required, proper medical treatment may be instituted before the dental treatment or concurrently with the dental appointments.

## Clinical examination of the patient

A logical and comprehensive sequence of examination procedures is highlighted, but as suggested in the foreword to this textbook, relevant material limited to providing care involving removable partial prosthodontics is the focus. The suggested sequence in the clinical examination process involves procedures with a prosthodontic and restorative focus, the periodontal examination, an examination of the mucosal and bony tissues including extraoral and intraoral soft-tissue evaluation, temporomandibular joint assessment, oral cancer screening, and an occlusion-oriented examination. Although the concept of examination focus areas represents the comprehensive approach, a practical approach to all areas can be accomplished in an efficient and methodical means toward developing a diagnosis. When followed, it ensures that no important diagnostic information is overlooked.

### *Oral hygiene status*

The dentist observes and makes annotations in the patient's record as to whether the current oral hygiene status reflects excellent, fair, or poor oral hygiene practices, as evidenced by the presence of food, bacterial plaque, or calculus. When an RPD is inserted, it is especially important that the patient's remaining natural teeth and tissues receive consistent and meticulous oral hygiene procedures in order for an acceptable degree of oral health to be maintained. The patient's oral hygiene status before prosthodontic treatment provides reliable evidence of the importance that the patient attaches to this critical factor and reflects if appropriate maintenance and oral hygiene instructions were provided and/or were understood from the prior treatment.

If inadequate oral hygiene practices are evident, the treatment plan must provide for a program of oral health care intervention and instruction. Control of dental plaque and maintenance of periodontal health are critical to the success of RPD treatment. Unless the patient is willing to cooperate and take responsibility in an effective plaque control regimen, the prognosis for the proposed treatment will be compromised. The location of unusual accumulations of calculus, plaque, or food debris should be recorded so that these areas may be rechecked at subsequent examinations.

### *Interproximal food impaction*

There are two types of interproximal food impaction: vertical food impaction, which is the forceful wedging of food against the gingival tissues and into the interproximal spaces through occlusal pressure, and horizontal food impaction, which is the forcing of food between the teeth by the tongue, lips, and cheeks. The dentist should note whether food impaction between two particular teeth is the result of inadequate natural teeth–occlusal marginal ridge relationships, inadequate interproximal contact areas, or if it is related to the opposing dentition.

### *Carious lesions and missing teeth*

Complete charting of all detectable carious lesions, existing restorations, defective restorations, and missing teeth is a routine part of the comprehensive examination. If possible, the age of certain restorations and/or prostheses should be determined during the patient interview. Areas of erosion or unusual abrasion should be checked at this phase of the examination, and areas that will require restoration should be recorded. The extent of dental caries activity shown in the patient's mouth is of great diagnostic importance. The dentist should evaluate the degree of caries susceptibility and record an assessment of this critical factor. If dental caries has been a significant problem, basic decisions will depend on the potential ability of the patient to control this disease.

All carious teeth must be restored prior to starting definitive prosthodontic treatment, both fixed and removable prosthodontic care. A treatment plan for a caries-prone patient should include participation in a caries control program, including a detailed home care plan to include fluoride treatment in addition to plaque control instruction and dietary counseling. After the elimination of all active carious lesions, an observation or "trial" period is recommended if the treatment schedule permits. During the trial period, the patient's oral hygiene practices and susceptibility to disease are reevaluated before prosthodontic treatment is begun.

### Periodontal health

The overall health of the periodontal tissues should include general color and texture of the gingival tissues, since gingiva are healthy pink in color, translucent, and have a dull stippled appearance with varying degrees of melanin pigmentation, as can be present in individuals of various ethnic origins. The color changes slightly at the line of demarcation between attached gingival tissues and the unattached alveolar mucosa. An erythematous, smooth, shiny appearance of the attached gingiva may indicate the presence of an inflammatory process. The marginal gingiva may turn red and the alveolar mucosa may become bluish-red when these tissues are congested as a result of infection. A pale, smooth appearance to the gingiva suggests the presence of anemia or other deficiencies. The texture of the zone of attached gingiva next to the teeth is examined. The attached gingiva is normally stippled, forming a firm, resilient cuff around a natural tooth. The band of attached gingiva varies but should provide an adequate zone of this keratinized tissue around teeth that are potential abutments for an RPD.

Pronounced soft-tissue undercuts will create problems if clasps or other components of an RPD must pass over them as the prosthesis is inserted for seating or removal. Any tissue clefts or areas of gingival recession that extend apically farther than the cementoenamel junction of any tooth should be noted in the clinical records.

Following the same orderly sequence as described in the caries examination, the dentist measures and records the depths of the periodontal pockets around all of the remaining teeth for a complete periodontal charting, which maps pocket depths versus use of the Periodontal Screening Record (PSR), which only indicates sextant measurements. This record is essential in determining the type of periodontal therapy, if any, that may be required prior to restorative and prosthodontic treatment. Any existing periodontal disease must be controlled before prosthodontic treatment is begun. The degree of mobility of all teeth should be recorded using a scale commonly used for classifying mobility:

- Class 1: A tooth demonstrates greater than normal movement, but less than 1 mm of movement in any direction.
- Class 2: A tooth moves 1 mm from normal position in any direction.
- Class 3: A tooth moves more than 2 mm in any direction, including rotation or depression. A change from normal physiologic movement may indicate traumatic occlusion or periodontal disease. Teeth exhibiting Class 3 mobility have a poor prognosis and usually will require extraction.

### Intraoral mucosa

The mucosa of the palate, edentulous ridges, tongue, cheeks, floor of the mouth, and vestibules should be examined. The location and appearance of any ulceration, areas of inflammation, or suspicious lesions are recorded and a differential diagnosis should be made. Irritations caused by rough teeth or broken restorations or due to an existing prosthesis should be noted.

Unusual white or red lesions anywhere in the oral cavity must be diagnosed and a biopsy may be required in order to verify the diagnosis.

Appropriate treatment should occur for a diagnosed condition prior to completion of prosthodontic care. In the instance of a patient who presents with an existing prosthesis, a fungal infection is seen frequently on the mucosa underneath existing complete and removable partial dentures, especially in the maxilla. Antimycotic therapy is required to control the infection before additional prosthodontic treatment is begun, which may also require intervention if the previous prosthesis is considered to be a potential source of the fungus. Candida infection is frequently associated with the presence of papillary hyperplasia of the palate.

### *Residual alveolar ridge*

The edentulous ridges are inspected visually and palpated with the fingertips. The size and shape of the ridges, as well as the height and location of the adjacent muscle and soft-tissue attachments, are noted. The ridges may be described in the clinical record as high, flat, narrow, or wide.

The relative firmness of the overlying mucosa is determined by palpation. Areas of flabby, movable, unsupported soft tissue over the denture-bearing regions of the residual ridges may be observed. When a patient wears an ill-fitting maxillary or mandibular RPD continuously without tissue rest, the soft tissues underlying the intaglio surface of the denture base are usually found to be inflamed, soft, and spongy to slight digital pressure. Pressure is exerted with the fingertips on several areas of the ridges to observe the tissue response. Areas that are sensitive to digital pressures should be noted. The crest and entire ridge should be palpated to detect the presence of sharp bony spines or ledges of bone. The capacity of the residual ridges to tolerate the pressure and friction of a tooth-tissue-borne RPD must be carefully assessed if an accurate prognosis for the outcome of prosthodontic treatment is to be made. The completed prosthesis will be considered unsuccessful if the denture-supporting tissues cannot, with reasonable comfort, bear the load placed on them.

Atrophic soft tissues are frequently found overlying the residual ridges of elderly or malnourished patients. This abnormal mucosa appears to be thin, smooth, and transparent, with a tissue color change that will blanch readily under moderate finger pressure. Patients with poor-quality soft tissue in denture-bearing areas may complain of a burning sensation. The tissues are usually sensitive to pressure, intolerant of pressure from denture bases, and slow to heal after injury. If the examination reveals this type of tissue covering potential denture-bearing areas, special note should be made in the examination record so that these factors will not be overlooked when the treatment plan is presented to the patient. The quality of tissues can influence the impression technique for a final impression, since unsupported tissues should not be under heavy compression using a high-viscosity impression material, which could physically displace the tissues from a "rest" position.

Whatever the clinical scenario, it is best to obtain better tissue health prior to fabrication of the definitive prosthesis. Ideally, the soft tissues overlying denture-bearing residual ridges should be wide, smooth, rounded, and covered with tough, firmly attached, keratinized mucosa. Ridges that are flat, narrow, or sharp and covered with flabby, unsupported tissue will not function well as areas of support. If any of these undesirable conditions exists, compromises in denture comfort and function must be anticipated, and the patient must be counseled accordingly. Mandibular residual ridges tend to exhibit undesirable characteristics more frequently than maxillary residual ridges, with the exception in the combination syndrome where the maxillary anterior residual ridge exhibits unsupported, hyperplastic tissue. Enlarged, hyperplastic tuberosities are frequently encountered in the maxillary arch. If these structures are flabby or spongy or if they intrude into the interridge space, it may serve the patient best to consider having surgical reduction of excessive tissue planned.

### *Tori*

If palatal or lingual tori are present, the dentist should record their locations and note whether surgical modification of the tori should be considered in treatment planning. Generally, small tori do not have to be removed when a patient is treated with an RPD. The major connector of the RPD can usually be designed around anatomic anomalies that are considered small in size. If the tori are very large or mushroom-shaped, or if they will otherwise interfere with comfort, function, or speech, they should be surgically removed prior to beginning prosthodontic treatment.

### *Occlusion*

The dentist should evaluate the patient in maximum intercuspation and centric relation. The demonstration of a "slide" between the initial contact and the position of maximum intercuspation indicates a discrepancy in jaw closure between centric relation and maximum intercuspation; this variance may be considered normal for the patient.

When a variance exists in a patient's occlusion, the dentist must decide if the clinical situation necessitates occlusal equilibration to make centric relation coincident with maximum intercuspation to create centric relation occlusion. The recontouring or restoration of teeth to make centric relation and maximum intercuspation positions coincident is not always required. Certainly, premature contacts in normal closure and deflective occlusal contacts that cause the mandible to slide protrusively or laterally must be corrected. The location of any abnormal deflective occlusal contacts or prematurities should be determined and recorded on the clinical chart.

Many dentists accept a discrepancy between centric relation and maximum intercuspation positions frequently encountered when the following conditions are met:

1. The jaw closure is smooth and consistent into the centric occlusion position.
2. There are multiple, simultaneous, stable occlusal contacts in the centric occlusion–maximum intercuspation position.
3. There is no evidence of a slide following the initial occlusal contact.
4. There are no symptoms of dysfunction; the patient is asymptomatic.

Many partially edentulous patients exhibit normal patterns of closure caused by deflective occlusal contacts and remain asymptomatic.

### *Occlusal plane*

The dentist should note the interocclusal relation of remaining teeth in centric relation position and in maximum intercuspation. Simultaneous examination of the articulated diagnostic casts is very helpful at this stage. Evaluate the orientation of the occlusal plane and note teeth that have supraerupted into opposing edentulous spaces to determine if additional treatment or intervention is necessary. If extruded teeth are left untreated, a poor occlusal plane could interfere with success of the proposed prosthodontic treatment. Also, the interarch space as defined by the proximity between the maxillary tuberosity and the mandible at the retromolar area should be assessed to see if there is adequate clearance for denture base coverage and extension. Correction of the occlusal plane discrepancy may require one of the following treatment alternatives, depending on the severity of the supraeruption:

1. Selective grinding of the cusps and/or enameloplasty of other occlusal surfaces.
2. Restoration with a crown at the proper occlusal height.
3. Gross occlusal reduction requiring subsequent restoration, often involving endodontic treatment.
4. Extraction of the tooth.

A "deep" or excessive anterior vertical overlap should be noted. Severe vertical overlap of the anterior teeth often results in problems in the design and fitting of RPDs. Excessive anterior

vertical overlap may also be a sign of posterior occlusal collapse, associated with accompanying loss of interarch space. Abnormal horizontal overlap relationships should also be noted if observed.

### Eccentric mandibular movements

The dentist should evaluate occlusal contacts in centric relation position and maximum intercuspation, but also when the patient moves the jaw throughout lateral excursive movements. Ideally, mandibular excursive movements should be guided by natural dentition, with natural tooth contact providing guidance in the left and right lateral excursive movements. Compromises in function and comfort with removable prostheses may be expected and problems of retention and stability of an RPD will certainly occur if the stresses of mandibular guidance fall onto the prosthetic teeth of the prosthesis.

Often, the loss of some teeth with potential drifting of adjacent remaining teeth can result in malpositioned teeth and traumatic occlusion, with mandibular guidance being forced upon weak teeth. Common signs of traumatic occlusion are tooth mobility or excessive attrition of the occlusal surfaces. Teeth that exhibit abnormal mobility during lateral jaw movements often have an unfavorable prognosis. The dentist should look for evidence of bruxism or clenching; mobile, chipped teeth, or severely worn opposing facets are possible signs of parafunctional habits. A person who clenches or experiences bruxism subjects natural tooth supporting structures and any prosthesis to destructive forces. If a parafunctional habit is verified or suspected, the patient must be counseled regarding the detrimental effects of the habit, which may necessitate fabrication of an occlusal device to prevent further destruction.

### Existing prosthesis

If the patient has been wearing an RPD, a great deal of useful information may be gleaned from examination of the prosthesis and the patient interview. Review factors that can be noted include the adequacy of the design (number and position of the direct retainers, major connector design and position, etc.), possible harmful effects resulting from poor framework fit, poor tissue adaptation, the size, type, and condition of the prosthetic teeth, denture base extension, and the occlusal scheme of the prosthesis. The patient history with the current prosthesis, such as how long the patient has worn the prosthesis and whether the prosthesis has ever been relined or rebased, should be ascertained. The dentist needs to determine if the patient feels that the current RPD has met his or her esthetic expectations. Are the anterior prosthetic teeth the appropriate size, form, and color, and do they adequately support the patient's facial musculature? Does the patient have any difficulty speaking with the prosthesis? Notes should be made of changes that need to be made or incorporated in the fabrication of a new prosthesis based on understanding the patient's perspective of satisfaction. However, the dentist must be careful not to change good features of the existing prosthesis to which the patient has adapted but only to modify unsuccessful features.

### Temporomandibular joint

The temporomandibular joints (TMJs) can be associated with myofascial pain-dysfunction. If a patient is experiencing symptoms of pain and muscular tenderness, the dentist should do a thorough evaluation to assess subjective and objective clinical signs and symptoms. Many factors can be considered in the differential diagnosis, including developmental disorders, TMJ arthritis, rheumatoid arthritis, trigeminal neuralgia, osteochondritis, osteoarthritis, posterior and anterior derangements, and referred pain, to list a few. Any functional abnormalities of joint function detected during the course of the comprehensive examination should be noted in the clinical record. In addition, comments by the patient regarding the TM function should be

recorded. Complaints of pain, tenderness, or swelling in the area of the TMJ should receive careful consideration and be addressed prior to rendering definitive prosthodontic care.

The TMJ is innervated by the masseteric nerve and the auriculotemporal nerve. The auriculotemporal nerve sends sensory fibers to the facial nerve, which complicates the differential diagnosis of pain in this region. When occlusal disharmonies exist, the muscles on that side of the jaw often contract to act as a physiologic splint to protect the masticatory system. This can be easily ascertained by palpating the rigidity of the muscles and comparing them to the ones of the contralateral side of the jaw. The internal pterygoid and masseter muscles form a sling for the mandible, and with the aid of the external pterygoid muscle hold the mandibular condyle and disk in a position of equilibrium on the articular eminence. All the muscles listed above and the temporal muscle may become rigid because of occlusal disharmonies. It is a physiologic reaction of the body to protect the stomatognathic system. However, the masseter and the internal pterygoid muscles on one side of the jaw are most often involved. To palpate the anterior fibers of the temporal muscle, the forefinger is placed on the cheek opposite the insertions of the muscle on the coronoid process. The other forefinger is placed inside the cheek opposite the contralateral finger. The masseter and internal pterygoid muscles are palpated with forefingers of each hand, one on the cheek and one opposing it in the mouth. The external pterygoid muscle cannot be palpated; however, patients with occlusal disharmonies exhibit tenderness in the region of the pterygomaxillary notch.

Treatment modalities prescribed for TM dysfunction of oral-facial pain are not described in detail and only mentioned from the perspective that the patient may require intervention prior to introducing a new prosthesis that could complicate evaluation of the existing condition. The treatment of the varied disorders associated with the temporomandibular joint and/or associated anatomical structures is beyond the scope of this book, but further diagnostic tests and appropriate therapy, if indicated, are necessary. In any case, treatment with a removable partial denture prosthesis should not be initiated until a state of health is managed by both the dentist and the patient. The jaws, as a functional unit of the stomatognathic system, involve three primary structural components: the teeth, the temporomandibular joints, and the neuromuscular complex. When these structural components function in harmony and within their physiologic tolerances, a state of mandibular equilibrium exists, and the teeth function smoothly within the stomatognathic system.

### Tongue

The size of the patient’s tongue should be observed in relation to the space available within the dental arches. If the lateral borders of the tongue protrude outward through the edentulous spaces, or if the tongue “overflows” the occlusal table of the remaining mandibular teeth, the patient may have problems adapting to the space defined by presence of a new prosthesis.

### Muscle tone

The tonicity of the extraoral muscles of the face and lips is an important factor in the success of prosthodontic treatment. In patients who have lost occlusal vertical dimension and extraoral facial support because of the detrimental consequences of long-standing edentulism or inadequate prosthodontic replacement of missing teeth, a decrease in muscle size and muscle tone is evident. Thin, soft lips, narrow vermilion borders, drooping corners of the mouth, and pronounced facial wrinkles are signs of aging that accompany the progression toward edentulism. Overall muscle tone should be noted in the clinical record as good, fair, or poor. Problems with esthetics and function are often complicated by the loss of muscle strength and tone. On the other hand, with a well-made prosthesis

providing appropriate extraoral muscle support, the facial appearance can be improved.

### Oral or systemic evidence of reduced tissue tolerance

The problem of reduced tissue tolerance is related to the systemic health of the patient. When oral or systemic conditions are not favorable, the added stress of an RPD on the abutment teeth and associated supporting tissues will be too great for these tissues to withstand. Thus, when the supporting tissues deteriorate, the RPD becomes unstable and there is an increase in the destructive forces on the remaining intraoral tissues, also adding unfavorable stress on supporting abutment teeth. The amount of remaining alveolar bone previously lost through systemic or local factors has a pertinent bearing on whether the remaining dentition should be retained or extracted. A patient's systemic condition and ability to provide a normal metabolic function are important factors in the success or failure of an RPD. Some systemic conditions that have intraoral manifestations can influence the success of prosthodontic treatment (Table 2.1).

## Radiographic evaluation diagnosis

In a comprehensive examination, prescribing a radiographic evaluation can include a panoramic radiograph, select periapical radiographs, and/or a complete series of radiographs (FMX) of the remaining natural teeth for complete diagnostic assessment. Anatomic relationships of the teeth, supporting tissues, and jaw bony structures are visualized readily on a panoramic radiograph. Periapical radiographs of the remaining teeth may also be required in order to supplement the panoramic radiograph. Teeth that have a questionable prognosis or that will probably require surgical, endodontic, or restorative treatment should be shown on individual periapical films, because resolution of detail is better on these films. When a panoramic radiograph is not available, a full-mouth series of periapical radiographs should be made.

In the radiographic examination and evaluation, special consideration is given to the diagnostic factors discussed below.

### Carious lesions

Initial carious lesions and recurrent caries adjacent to existing restorations should be noted. Deep lesions or extensive restorations in teeth that are potential abutments for prostheses should receive special scrutiny. Obvious indications for endodontic therapy or for cast restorations should be recorded.

### Alveolar bone resorption

In most partially edentulous patients, some loss of alveolar bone will be evident, and in many patients the bone loss will be severe, as judged on the radiographs by the height of the alveolar crest levels around the roots of the remaining teeth.

Both the quantity and quality of the bone support for potential abutment teeth are critical factors in the long-term success of an RPD, so a careful evaluation of these factors must be made at this time. Abutment teeth will be called on to withstand greater than normal vertical, horizontal, and torque forces applied to them by the prosthesis. A tooth that has lost one-third or more of its alveolar support may not be strong enough to bear these unusual loads.

The radiographic crown-root ratio is a commonly used index for classifying the degree of existing support for teeth being evaluated as probable abutments. The length of the tooth occlusal from the crest of the alveolar bone is compared with the length of the tooth root apical from the alveolar crest, and the comparison is expressed as an approximate ratio.

A tooth with normal, undiminished alveolar support will have a crown-root ratio of approximately 1:2. A tooth that extends as far above its supporting alveolus as its root extends into the

**Table 2.1.** Systemic changes in the RPD patient important to the general practitioner (Renner RP, Boucher LJ. *Removable Partial Dentures*. Chicago: Quintessence Publishing Co., 1987).

| Systemic Condition | Clinical Signs and Symptoms | Mucosal Alterations | Bony Alterations | Muscle and Central Nervous System Alterations | Prosthodontic Considerations |
|---|---|---|---|---|---|
| Pernicious anemia | Xerostomia, disturbance of taste sensation | Susceptibility to denture trauma | — | — | Monitor denture stability and occlusion required to minimize pressure areas. Poor denture retention results from lack of saliva. |
| Vitamin or nutritional deficiencies | Xerostomia, loss of appetite, decline in taste sensibility, capillary fragility, weight loss, general weakness | Difficult regenerations, susceptibility to RPD trauma, thinning, easy abrasion (dry mucosa adheres to RPDs and is easily abraded), reduced resistance to infection | Osteoporosis with severe alveolar destruction with loss of Ca intake and Ca/Po | Muscle weakness, fatigue, and depression | Dietary counseling and supplementation are needed when eating habits cannot be changed. Proper base extension and stability are needed to prevent mucosal irritation. |
| Hypertension | Difficult breathing on exertion, angina on effort, palpitations, epistaxis, headache, dizziness | — | — | — | Avoiding hypertensive episodes is important. Compliance with physician's instructions and medications should be confirmed. Reduce length of appointments and provide a reassuring attitude and environment. |
| Diabetes | Xerostomia; increased thirst, hunger and urinary output; weakness and rapid weight loss | Susceptibility to RPD trauma, reduced tissue tolerance to RPD, mucosal hyperemia and swelling, burning sensation on palate | Reduced bone tolerance to RPD, rapid bone loss with elevated blood glucose levels | | Borders should not be overextended. Patient's mouth is prone to sore spots. Patient must maintain good tissue hygiene and employ times for tissue rest, without wearing the prosthesis. Dentist should recall patient to monitor tissue health and verify occlusion. |
| Osteoporosis | Decrease in skeletal mass and radiographic decrease in bone density; tendency of onset in females vs. males as a result of normal aging | | Marked alveolar ridge resorption with advancing age, generalized osteoporosis of maxilla and mandible during sixth decade and beyond | | Patient has tendency to narrowing of maxillary ridge and broadening of mandibular ridge, leading to appearance of horizontal discrepancies, i.e., posterior "crossbite." Occlusion should be evaluated and maximum coverage of residual ridges should be provided for support. |

(Continued)

**Table 2.1.** *Continued*

| Systemic Condition | Clinical Signs and Symptoms | Mucosal Alterations | Bony Alterations | Muscle and Central Nervous System Alterations | Prosthodontic Considerations |
|---|---|---|---|---|---|
| Lichen planus | Mucosal inflammation and pain, hyperkeratosis | Epithelial erosion, ulceration, mucosal plaque formation | | | Severe cases of erosive lichen planus may prevent the comfortable wearing of RPDs. |
| Fungal infections | Easily removed curd-like lesions | Inflammation, "milk curd" appearing lesions | | | Dentist should eradicate fungal lesions with antimycotic therapy before RPD is fabricated. |
| Postradiation therapy | Xerostomia, osteomyelitis, necrosis trismus of muscles of mastication | Susceptibility to RPD trauma, necrosis from radiation-induced vascular changes | Necrosis of bone from radiation-induced vascular changes | Muscle trismus | Dentist must monitor fit and correct fit when sore spots exist in a rapid manner. Overextensions should be avoided so that they do not become secondarily infected, leading to osteoradionecrosis. Xerostomia reduces patient's ability to wear removable prostheses. Occlusal vertical dimension is reduced due to muscle trismus. |
| Climacteric (i.e., menopausal changes) | Tendency to gag, burning sensation, xerostomia, vague areas of pain, taste alterations | Glistening, reddening, (erythema) and edema; susceptibility to RPD trauma; burning tongue and palate; epithelial sloughing; loss of keratin from mucosa | Generalized osteoporosis | Potential psychologic changes and emotional instability | Longer adjustment phase to RPD is required due to mucosal and psychologic changes. |
| Chronic pulmonary disease (i.e., emphysema and chronic bronchitis) | Shortness of breath, wheezing, increased respiratory rate, persistent cough | | | Decreased muscle tone, lowered sensitivity to stimuli, low cough reflex | Patient has little pulmonary reserve and poor reaction to stress. Dentist should keep appointments short. Occlusal vertical dimension is difficult to record because of patient's tendency to mouth breathe. |

| | | | | | |
|---|---|---|---|---|---|
| Salivary gland disorders | Xerostomia, painful and burning mucosa | Mucosal sensitivity, plaque retention, mucosal abrasion and ulceration from denture base | | | Wearing the RPD becomes intolerable because of pain, burning, and frictional abrasion of the oral membranes from tissue-fitting and polished surfaces. |
| Neurologic disorders | | | | | |
| Bell's palsy | Facial paralysis with mouth drawn over to opposite side; saliva runs from angle of mouth. | Numbness on affected side, inability to feel collected food in buccal sulcus | | Inability to retract corner of mouth or to posture mouth to whistle | Dentist should not overstretch the angle of mouth and should add sufficient bulk to buccal surface contour of maxillary RPD to support flaccid muscles. |
| Parkinsonism | Impaired movement, muscular rigidity, tremor, slowness, limited range of movement | Soft, hypokeratinized mucosa, denture stomatitis | | Speech difficulty, increased salivation, difficulty in mastication because of muscle tremors | Dentist should teach careful oral hygiene, use of tissue conditioners, and balanced occlusion. Retention is impaired from increased salivation. Maximum peripheral extension decreases denture retention. Patient lacks muscular coordination to control the prosthesis. Determination of occlusal vertical dimension is difficult because of tremor and muscle hypertonicity. |
| TM disturbances | Pain and tenderness of joint | | | Limited range of motion of the mandible | History of subluxation could prohibit extensive dental procedures such as impressioning or making maxillomandibular relation records. Frequent occlusal adjustments may be necessary. |

alveolar bone is said to have a crown-root ratio of 1:1.

As a general diagnostic guide, a tooth with a crown-root ratio of more than 1:1 is considered to have an unfavorable prognosis as an abutment tooth. However, the clinical mobility and periodontal health of the tooth as well as the number of other potential abutments that will be used to support the RPD must also be considered when treatment planning decisions are made. Alternative types of RPDs, such as the swing-lock type, or treatment of the patient with overdentures should be considered in patients whose teeth have questionable alveolar bony support.

### *Bone density*

The relative radiographic density of the bone around the remaining teeth, particularly in the vicinity of potential abutment teeth, should be closely observed. Areas of bone around teeth that have been subjected to unusual lateral or occlusal stresses have been referred to as "bone index areas." The response of the bone to heavy functional loads, as demonstrated in the index areas, is diagnostically significant. An increased degree of trabeculation and condensation of the bone close to stressed teeth is a favorable sign. Bone that is translucent on a radiograph, with sparse trabecula and thin lamina dura, suggests a guarded prognosis for the teeth in question.

The density of the bone in residual ridge areas is likewise of diagnostic importance. Heavy trabeculation and thick cortical plates signify a favorable prognosis for the supportive capacity of the residual ridge. Areas of bone that are relatively radiolucent and poorly trabeculated and that exhibit a thin or interrupted superior cortical plate may be expected to undergo comparatively rapid and severe resorption and are poorly suited for support of a removable prosthesis.

### *Root configuration*

The size and shape of the roots of potential abutment teeth, as shown in the radiographs, are of value in determining the resistance of the teeth to the additional forces to which they will be subjected. Abutments with long, multiple, and divergent roots will have a favorable prognosis, because the forces transmitted to them will be distributed to a larger number of periodontal ligament fibers and to a greater area of supporting alveolar bone. Teeth with short, conical, or fused roots will have an unfavorable prognosis because of their decreased resistance to the forces of function.

### *Periodontal ligaments and the lamina dura*

The width of the periodontal ligament around the roots of the teeth is of significance in evaluating the stability of the teeth. A thin, uniform ligament space is a more favorable sign than is a widened, irregular space. The lamina dura is a thin plate of bone that surrounds the root of each tooth and provides attachment for the periodontal ligament. On a radiograph, it appears as a radiopaque line outlining the alveolus. A thin, irregular, or interrupted lamina dura may indicate the presence of traumatic occlusion, periodontal destruction, or systemic bone disease. Abnormal areas, if observed, should be noted. It must be remembered, however, that radiographs do not show the relationship between periodontal pocket depth and alveolar bone resorption.

### *Radiolucent or radiopaque lesions*

The presence of cysts, abscesses, embedded teeth or roots, or foreign bodies should be noted so that appropriate surgical diagnosis and treatment may be planned. Buried root tips or impacted teeth that show no sign of pathology and are encapsulated by normal-appearing bone need not always be surgically removed.

## Analysis of the diagnostic casts

It is essential that accurate casts of the dental arches be available at the time of the diagnostic

examination. The casts should be mounted in centric relation position on a semiadjustable dental articulator. A facebow registration and centric relation record are used for mounting the diagnostic casts.

Criteria for the acceptability of diagnostic casts include the following:

1. Anatomic details of the dental arches should be accurately reproduced, including the teeth, gingival tissues, frenum attachments, and residual ridges.
2. There should be no dental stone nodules, voids, or artifacts in critical anatomic areas of the casts.
3. The bases of the diagnostic casts should be 10–15 mm thick at the thinnest areas.
4. The bases of the casts should be approximately parallel to the occlusal plane of the dental arch.
5. The sides of the diagnostic cast should be neatly trimmed perpendicular to the base and a few millimeters outside the depth of the vestibular tissues.
6. The "tongue space" of the mandibular cast should be clear of unnecessary dental stone, approximately level with the depth of the lingual vestibules. This can be created with ease at the time of pouring the impression by using additional alginate impression material to "fill" the tongue space and render the area smooth and even with the depth of the lingual vestibules.

### *Evaluation of the mounted diagnostic casts*

- Occlusal relationships: Normal and abnormal occlusal contacts between opposing teeth can be studied more easily with mounted diagnostic casts compared with evaluation intraorally. Deflective occlusal contacts, or interferences between centric relation and centric occlusion positions, are critical factors to assess.
- Occlusal plane: The plane of the occlusal surfaces of the teeth should be evaluated very carefully. In a patient who is partially edentulous, the drifting and extrusion of the remaining teeth tend to create an uneven or irregular occlusal plane. The resulting malocclusion can result in a traumatic occlusion affecting teeth, their supporting structures, and the temporomandibular joints. Extruded or tipped teeth that violate the regularity of the occlusal plane require modification by means of selective grinding or placement of cast restorations. Severely malpositioned teeth may require orthodontic therapy, surgical orthodontic therapy, or extraction. It is desirable for the posterior height of the mandibular plane of occlusion to be near the level of the center of the retromolar pad. Occlusal planes that have been grossly disoriented because of the extruded teeth or because of enlargement of the maxillary tuberosities must be corrected.
- Abutment tooth contours: The contours and axial inclinations of potential abutment teeth should be evaluated to determine if the fit of a fixed partial denture or the path of insertion/removal of a removable partial denture is practical. Teeth used as RPD abutments often require recontouring to reduce undesirable undercuts and to enhance contours favorable for clasping. Simple enameloplasty without penetrating into dentin can serve as a solution when trying to create an ideal contour versus requiring a full coverage crown—survey crown—to meet the needs of the RPD undercuts for retentive elements. Also, the use of composite resin to alter the contours can be a conservative treatment alternative versus requiring a full coverage crown. Teeth that have inclinations unfavorable for clasping or that have contours grossly inadequate for rest seats, guide planes, or retentive areas will require cast restorations—survey crowns.
- Rest seat areas: Occlusal contacts of anterior and posterior teeth in maximum intercuspation should be evaluated carefully at sites where rest seats are desirable. Rest seats on maxillary anterior teeth must be placed in areas that will not interfere with the occlusion

of the mandibular anterior teeth, as the rest seat will have the corresponding framework opposing the opposite dentition.

If using adjacent embrasure rest seats, this requires sufficient reduction to accommodate the occlusal rests and the connection to the embrasure clasps. Occasionally, the casts will reveal the need to reduce an opposing cusp tip for clearance of an occlusal rest or an embrasure clasp. To create sufficient clearance, two 18-gauge orthodontic wires placed side by side can be used to provide an objective measure when preparing the natural teeth to accommodate embrasure rest seats and adjacent embrasure clasps.

- Interarch space (interarch distance): The space available between opposing residual ridges or between the teeth of one arch and the residual ridge of the opposing arch is of diagnostic significance. Insufficient space for the components of a proposed prosthesis or for the establishment of an acceptable plane of occlusion is a problem requiring correction. Surgical reduction of enlarged tuberosities or irregular residual ridges is frequently indicated to allow the placement of an RPD with a favorable occlusal plane.
- Residual ridge relation: The horizontal as well as the vertical relationships between opposing arches are important and can be evaluated by assessing the mounted diagnostic casts. The need to consider horizontal occlusal relationships such as excessive horizontal overlap or "cross-bite" will be revealed by observing the relationship observed on the mounted diagnostic casts.
- Tissue contours: Some soft-tissue contours and undercuts are often more clearly demonstrated on the diagnostic casts than in the patient's mouth. On the diagnostic casts, the size and shape of bony tori are evident, as well as bony protuberances or sharp exostoses that could interfere with the placement of an RPD. Sharp or severely undercut mylohyoid ridges may require surgical modification.

## Evaluation of the patient's psychological status

Personal and psychological factors are significant to the success of prosthodontic treatment comparable to the patient's physical condition. Before proceeding with definitive treatment planning, it is critical to assess the patient's attitudes toward his or her oral health and dental treatment. By the end of the interview and examination, the dentist must form an opinion as to whether the patient's expectations will contribute to a successful prognosis. Each individual has distinct personality traits that, when evaluated, may help to predict the course of prosthodontic treatment. A system for classifying dental patients may help the dentist anticipate the response of an individual patient. One useful classification describes four types of patients: philosophic, emotional, exacting, and indifferent.

- Philosophic patients are rational and well-balanced. They realize the importance of a healthy mouth. They do not expect perfection but rather a reasonable degree of esthetics, comfort, and efficiency in their prostheses.
- Emotional patients can be nervous, temperamental, and unreasonable. Their dental history reveals neglect and fear of dentists. They are pessimistic about their ability to wear a dental prosthesis successfully. They tend to be suspicious of the dentist's ability and intentions. They exaggerate symptoms and problems.
- Exacting patients are perfectionists and demand unrealistic degrees of perfection from the completed treatment. These patients are unwilling to accept changes in their oral hygiene and eating habits. They will expect the same efficiency in chewing that they had with their natural teeth. They are critical of the minutest details of esthetics, fit, and function. They usually are critical of previous dentists, and they often request written guarantees.
- Indifferent patients are unconcerned about their appearance and their oral health. They

have neglected, unhealthy mouths. They exhibit little patience or perseverance in adapting to a prosthesis, and will often remove it for the least excuse. Because they offer no opinions or suggestions during the examination and treatment, they lead the dentist to believe that treatment will be easy. After a prosthesis is completed, however, they often prove to be uncooperative and difficult patients.

A patient's past experience with dentists and with dental treatment, as explored in the initial interview, provides some of the best clues to the patient's attitude and motivation. The dentist's assessment of these factors must be recorded, since they must be considered in establishing a treatment plan and prognosis.

## Evaluation of the patient's economic priorities

It is important for the dentist to discuss the patient's economic priorities and limitations. The patient's practical financial limitations should be respected among the factors involved in treatment planning.

## Prosthodontic Diagnostic Index (PDI)

The American College of Prosthodontists (ACP) has developed a classification system for partial edentulism based on diagnostic findings. This classification system is similar to the classification system for complete edentulism previously developed by the ACP. These guidelines are intended to help practitioners determine appropriate treatments for their patients. Four categories of partial edentulism are defined, Class I to Class IV, with Class I representing an uncomplicated clinical situation and Class IV representing a complex clinical situation. Each class is differentiated by specific diagnostic criteria. This system is designed for use by dental professionals involved in the diagnosis and treatment of partially edentulous patients. Potential benefits of the system include

1. Improved intraoperator consistency.
2. Improved professional communication.
3. Insurance reimbursement commensurate with complexity of care.
4. Enhanced diagnostic consistency.
5. Simplified aid in the decision to refer a patient.

When reviewing criteria to determine the patient's classification as it relates to the PDI for the partially edentulous patient, there are four criteria specific for this type of patient: location and extent of the edentulous area(s), condition of abutments, occlusion, and residual ridge characteristics. Basic information is provided for the clinician, but specific details and extensive clinical photos are available in the scientific literature as described by McGarry et al.

- Criteria 1: Location and extent of the edentulous area(s) include four levels described as ideal or minimally compromised edentulous area (single arch), moderately compromised edentulous area (both arches), substantially compromised edentulous area, and severely compromised edentulous area.
- Criteria 2: Abutment conditions are described as ideal or minimally compromised abutment, moderately compromised abutment, substantially compromised abutment, and severely compromised abutment condition.
- Criteria 3: Occlusion includes ideal or minimally compromised occlusal characteristics, moderately compromised occlusal characteristics (some adjunctive adjustments and Angle's Class I jaw/molar relation), substantially compromised occlusal characteristics (reestablishment of occlusion and Angle's Class II jaw/molar relation), and severely compromised occlusal characteristics (reestablishment of occlusion and occlusal vertical dimension [OVD], and Angle's Class II Div 2 and Class III jaw/molar relation).
- Criteria 4: Residual ridge classification follows that is used to categorize any of the edentulous areas that will be restored in the partially edentulous patient (Table 2.2). A worksheet is included in Table 2.3 with guidelines for its use.

**Table 2.2.** ACP classification system of complete edentulism. Reprinted with permission from "Classification System for Partial Edentulism," *Journal of Prosthodontics* Vol. 11, no. 3, 2002: 181–193.

ACP Classification System of Complete Edentulism

***Class I***

This class characterizes the stage of edentulism that is most apt to be successfully treated with complete dentures using conventional prosthodontic techniques. All 4 of the diagnostic criteria are favorable.

- Residual bone height of ≥21 mm measured at the least vertical height of the mandible on a panoramic radiograph
- Residual ridge morphology resistant to horizontal and vertical movement of the denture base; type A maxilla
- Location of muscle attachments conducive to denture base stability and retention; type A or B mandible
- Class I maxillomandibular relationship

***Class II***

This class is distinguished by the continued physical degradation of the denture-supporting anatomy. It is also characterized by the early onset of systemic disease interactions and by specific patient management and lifestyle considerations.

- Residual bone height of 16 to 20 mm measured at the least vertical height of the mandible on a panoramic radiograph
- Residual ridge morphology resistant to horizontal and vertical movement of the denture base; type A or B maxilla
- Location of muscle attachments with limited influence on denture base stability and retention; type A or B mandible
- Class I maxillomandibular relationship
- Minor modifiers, psychosocial considerations, mild systemic disease with oral manifestations

***Class III***

This class is characterized by the need for surgical revision of supporting structures to allow for adequate prosthodontic function. Additional factors now play a significant role in treatment outcomes.

- Residual alveolar bone height of 11 to 15 mm measured at the lease vertical height of the mandible on a panoramic radiograph
- Residual ridge morphology with minimum influence to resist horizontal or vertical movement of the denture base; type C maxilla
- Location of muscle attachments with moderate influence on denture base stability and retention; type C mandible
- Class I, II, or III maxillomandibular relationship
- Conditions requiring preprosthetic surgery
  - Minor soft tissue procedures
  - Minor hard tissue procedures including aveoloplasty
  - Simple implant placement; no augmentation required
  - Multiple extractions leading to complete edentulism for immediate denture placement
  - Limited interarch space (18 to 20 mm)
- Moderate psychosocial considerations and/or moderate oral manifestations of systemic diseases or conditions such as xerostomia
- TMD symptoms
- Large tongue (occludes interdental space) with or without hyperactivity
- Hyperactive gag reflex

***Class IV***

This class represents the most debilitated edentulous condition. Surgical reconstruction is almost always indicated but cannot always be accomplished because of the patient's health, preferences, past dental history, and financial considerations. When surgical revision is not an option, prosthodontic techniques of a specialized nature must be used to achieve an adequate outcome.

- Residual vertical bone height of ≤10 mm measured at the least vertical height of the mandible on a panoramic radiograph
- Class, I, II, or III maxillomandibular relationships
- Residual ridge offering no resistance to horizontal or vertical movement; type D maxilla
- Muscle attachment location that can be expected to have significant influence on denture base stability and retention; type D or E mandible
  - Major conditions requiring preprosthetic surgery
  - Complex implant placement, augmentation required
  - Surgical correction of dentofacial deformities required
  - Hard tissue augmentation required
  - Major soft tissue revision required, that is, vestibular extensions with or without soft tissue grafting

**Table 2.2.** *Continued*

- History of paresthesia or dysesthesia
- Insufficient interarch space necessitating surgical correction
- Acquired or congenital maxillofacial defects
- Severe oral manifestation of systemic disease or conditions such as sequelae from oncologic treatment
- Maxillomandibular ataxia (incoordination)
- Hyperactivity of tongue possibly associated with a retracted tongue position and/or its associated morphology
- Hyperactive gag reflex managed with medication
- Refractory patient (a patient who presents with chronic complaints following appropriate therapy), who may continue to have difficulty achieving their treatment expectations despite the thoroughness or frequency of the treatments provided
- Psychosocial conditions warranting professional intervention

**Table 2.3.** Worksheet used to determine classification. Reprinted from "Classification System for Partial Edentulism," *Journal of Prosthodontics* Vol. 11, no. 3, 2002: 181–193.

| | Class I | Class II | Class III | Class IV |
|---|---|---|---|---|
| Location & Extent of Edentulous Areas | | | | |
| Ideal or minimally compromised—single arch | | | | |
| Moderately compromised—both arches | | | | |
| Substantially compromised—>3 teeth | | | | |
| Severely compromised—guarded prognosis | | | | |
| Congenital or acquired maxillofacial defect | | | | |
| Abutment Condition | | | | |
| Ideal or minimally compromised | | | | |
| Moderately compromised—1–2 sextants | | | | |
| Substantially compromised—3 sextants | | | | |
| Severely compromised—4 or more sextants | | | | |
| Occlusion | | | | |
| Ideal or minimally compromised | | | | |
| Moderately compromised—local adjunctive tx | | | | |
| Substantially compromised—occlusal scheme | | | | |
| Severely compromised—change in OVD | | | | |
| Residual Ridge | | | | |
| Class I Edentulous | | | | |
| Class II Edentulous | | | | |
| Class III Edentulous | | | | |
| Class IV Edentulous | | | | |
| Conditions Creating a Guarded Prognosis | | | | |
| Severe oral manifestations of systemic disease | | | | |
| Maxillomandibular dyskinesia and/or ataxia | | | | |
| Refractory patient | | | | |

NOTE. Individual diagnostic criteria are evaluated and the appropriate box is checked. The most advanced finding determines the final classification.

*Guidelines for use of the worksheet*

1. Any single criterion of a more complex class places the patient into the more complex class.
2. Consideration of future treatment procedures must not influence the diagnostic level.
3. Initial preprosthetic treatment and/or adjunctive therapy can change the initial classification level.
4. If there is an esthetic concern/challenge, the classification is increased in complexity by one level in Class I and II patients.
5. In the presence of TMD symptoms, the classification is increased in complexity by one or more levels in Class I and II patients.
6. In the situation where the patient presents with an edentulous mandible opposing a partially endentulous or dentate maxilla, Class IV.

## Prosthodontic treatment choices

All significant items of information from the interview, oral examination, radiographic survey, and evaluation of the diagnostic casts can now be correlated to complete the diagnosis for the partially edentulous patient. When the patient's problems and needs have been analyzed, the dentist may begin answering the five basic questions introduced at the beginning of this chapter. The answers to these questions are incorporated in the treatment plan. To rephrase, the first question is, "What type of prosthodontic treatment will best serve this patient's needs when all of the relevant factors or viewpoints are considered?" These factors include

1. The patient's systemic and oral health. A healthy patient may have a healthy mouth, and this combination speaks well for successful treatment. However, complicated, heroic, or risky treatments are not usually indicated for patients with chronic health problems.
2. The patient's age. The age of an older patient may only be important as it affects the patient's physical and mental health and economic status.
3. Physiologic and mechanical considerations.
4. The patient's expectations and the value and emphasis for his or her oral health care. The desire of the patient to save versus lose teeth must be considered since it will influence the final treatment plan.
5. The patient's psychological status.
6. The economic status and priorities of the patient. Financial factors and the benefits and limitations of dental insurance are significant in the treatment choices available to the patient.

## Combinations of fixed and removable partial dentures

Certain situations call for the use of a combination of fixed and removable partial dentures. For example, missing anterior teeth with minimal alveolar bone loss should be replaced by an FPD even when posterior teeth are to be replaced by an RPD, for the following reasons:

1. The FPD eliminates the unfavorable leverages that exist when replacement denture teeth are attached to the RPD anterior to the fulcrum line.
2. Patients will be more apt to remove the RPD at night to rest the tissues if anterior esthetics are not compromised in doing so.
3. Esthetics will not be a consideration if the posterior RPD has to be repaired or replaced.

An FPD should also be used for splinting an isolated posterior tooth that is to be a terminal abutment for an RPD. Lone-standing mandibular second premolars occasionally present this situation following the loss of the first premolar. In this clinical situation, the second premolar is vulnerable to unfavorable leverages placed on it by a distal-extension RPD. Splinted to the adjacent canine by an FPD, the second premolar may function well as an RPD abutment tooth.

When only two canines remain in the dental arch, cross-arch stabilization, that is, a bar fabricated between cast restorations placed on canines, may be used to provide support and retention for an RPD. The bar provides a favorable distribution of forces transmitted to it, dividing them between the two splinted teeth.

### *Removable partial denture*

An RPD is the restoration of choice under the following conditions:

1. When there are no posterior terminal abutment teeth present, so that a distal-extension base is required to support the prosthesis.
2. When the edentulous spaces are too extensive or too curved to be successfully restored with an FPD.
3. When there is a need to provide replacement for missing hard and soft tissues with an acrylic resin denture base in order to restore normal tissue contours and lip support.

4. When the cross-arch splinting provided by an RPD will be helpful in supporting and preserving periodontally weakened teeth.
5. When potential abutment teeth have not fully erupted, so that treatment with an FPD is not feasible. This situation is not uncommon among young patients.
6. When only periodontally weakened anterior teeth remain to provide anchorage for a prosthesis. Special design adaptations, such as the swing-lock partial denture or a removable partial overdenture, may be employed to reduce stress on the weak abutment teeth. The progression to an overdenture or a complete denture may thus be postponed.
7. When it is anticipated that additional teeth will be lost sometime after the fabrication of the prosthesis. Additional denture teeth may be added to an RPD that has been designed with this contingency in mind. A tooth-supported RPD may even be converted to a distal-extension RPD by the addition of a denture tooth and an appropriate denture base.
8. When the difference in cost between RPD treatment and extensive FPD treatment may be a significant deciding factor for a patient with limited finances.

In making a choice between treatment with an FPD or an RPD, the dentist should consider the advantages of an RPD.

In choosing between treating a patient with an RPD or a CD, the dentist should remember the following additional points:

1. Retention of teeth preserves alveolar bone. Early extraction of teeth, particularly in young patients, may prematurely hasten the destructive resorption of essential supporting bone.
2. A mandibular RPD is generally more stable and functional than is a mandibular CD; thus it is easier for most patients to learn to wear. For these reasons, it is advisable to retain, whenever possible, strategic mandibular teeth to support an RPD or overdenture.

**Advantages of an RPD**

1. An RPD can replace lost supporting tissues in addition to missing teeth. Normal contour, appearance, and facial support may be restored with the acrylic resin denture base material where bone and alveolar tissue have been lost.
2. An RPD can use soft tissue areas of the mouth for support in addition to using the teeth, so an RPD may function successfully when the teeth alone cannot support an FPD.
3. An RPD may help the patient maintain a more acceptable level of oral hygiene. Use of an RPD enables the patient to clean both the prosthesis and the remaining natural teeth, since the prosthesis can be removed.
4. An RPD may be designed to splint and stabilize weakened abutment teeth and prevent the loosening, drifting, or extrusion of retained teeth. The cost of cast restorations and the problem of unhygienic soldered splints may sometimes be avoided when an RPD is used.
5. An RPD may be designed to distribute the forces of mastication on to many support areas and to multiple abutment teeth to prevent overloading only two or three teeth.

### Combinations of CDs and RPDs

Quite often, the maxillary and mandibular arches are restored with different types of prostheses, because the indications for treatment for the separate arches may vary. For example, a clinical situation encountered very frequently is an indication for a CD in the maxillary arch occluding with an RPD in the mandibular arch. This combination of prostheses is usually successful, providing that proper support of the mandibular RPD is maintained throughout the life of the prosthesis. A mandibular CD opposed by natural teeth in the maxillary arch is less well tolerated. The patient's well-supported maxillary teeth can exert much more force on the mandibular denture than the edentulous mandibular ridges can withstand, and therefore the tissues beneath the mandibular denture are constantly traumatized. The consequences are continual soreness and accelerated resorption of the mandibular residual ridge. Again, this situation emphasizes the importance of retaining even a few mandibular teeth (for an RPD or overdenture) to aid in withstanding the forces of mastication.

## Treatment planning

Following the diagnostic review, if it has been determined that the needs of the patient will best be met by treatment with an RPD, the next decision in the sequence is, "What will be the most functional design for the RPD?" The design process begins with the selection of the teeth for use as abutments.

### Selection of the abutment teeth

Diagnostic evaluations of potential abutment teeth were made during the examinations of the mouth, the radiographs, and the mounted diagnostic casts. In choosing the specific teeth, it must be remembered that abutment teeth must withstand unusual vertical, horizontal, and torque forces that are transmitted to them by the RPD in function. In review, the teeth selected as abutments should have the following characteristics:

1. Adequate support for the roots. Factors of support discussed previously include the crown-root ratio, the quality of the alveolar bone surrounding the root or roots, the size and shape of the roots, and the thickness of the periodontal ligament. Minimal mobility is desirable.
2. Healthy periodontal tissues, including an adequate zone of attached gingiva. The presence of minimal periodontal pockets is a favorable factor.
3. Healthy coronal structure, or the tooth's capability of being restored so that its coronal portion is strong enough to serve as an abutment.
4. Coronal morphologic features that are favorable for the preparation of rest seats for support and of guiding planes for guidance of the RPD during insertion and removal.
5. Axial alignment that permits a reasonable path of insertion and allows the forces of occlusion to be directed vertically along the axis of the roots.
6. Coronal morphologic features that are favorable for clasping with reference to the most logical path of insertion. Note: Characteristics 3, 4, 5, and 6 can often be enhanced with the placement of cast restorations.
7. The position of the teeth in the dental arch that facilitates the favorable distribution of stress. Teeth that are in contact with other teeth in the arch are better able to withstand stress than are isolated teeth.
8. The absence of pulpal or periapical pathosis.

### Design of the removable partial denture

When the abutment teeth have been evaluated and chosen, a tentative design for the RPD should be carefully considered and made as

described. The dentist develops the design, following the essential principles of support, retention, bracing, guidance, and stress control. The sequence of steps involved in diagnostic cast evaluation and designing the RPD is described in detail in chapter 3.

### *Responsibility of the dentist*

It must be emphasized that the dentist should prescribe the RPD. Only the dentist who has performed the examination of the patient and who is familiar with all of the relevant factors is in a position to determine which design features of an RPD are physiologically acceptable and feasible from a biomechanical perspective. The dentist is the professional best qualified to ensure that the design will meet the important requirements of preserving the remaining natural teeth and tissues and providing the best obtainable function, comfort, and appearance.

### *Preeminence of the RPD treatment plan*

Most patients for whom RPD treatment is indicated will also require other treatment, such as operative dentistry and periodontal therapy. The fitting of an RPD is usually only the last phase of the total treatment plan. It cannot be emphasized too strongly that whenever a patient is to receive an RPD, the prosthodontic treatment plan is the key plan with which all other treatment plans must be coordinated. The design of the RPD will determine to a great degree the types of intervention and/or adjunctive therapy necessary when considering surgical, periodontal, and operative dentistry treatments that will be required for the optimal degree of rehabilitation. Therefore, it is vital to plan the RPD first. If this principle is violated, the dentist may discover, following the completion of other treatment, such situations as improperly contoured abutment crowns or teeth that have been restored to poor intraoral conditions that existed previously and compromise ultimate success. Without proper treatment planning and subsequent sequence of treatment outlined, expensive and time-consuming adjunctive therapy might be required.

The dentist can avoid these frustrating situations by determining in advance adjunctive treatment requirements prior to prescription and fabrication of the RPD. Even though the prosthodontic treatment is commonly done last, it must be planned first, because its success depends to a great extent on the degree to which other treatments complement it.

### *Adjunctive dental treatment planning*

For optimal function and comfort to be achieved with RPD treatment, the patient's oral tissues must be brought to the best possible state of health before the RPD is constructed. Various surgical, periodontal, and operative dentistry procedures are commonly required to complement the prosthodontic treatment. The sequencing of these procedures should be planned in advance to ensure efficient management of the patient's comprehensive treatment. Although in practice the order of treatment may vary, a logical sequence for planning is suggested below.

- Surgical procedures: Surgical procedures should be scheduled early so that postoperative healing may proceed as quickly as possible. Final impressions for the construction of the RPDs are usually postponed until optimal surgical healing has occurred. Decisions regarding teeth that require extraction because of extrusion, periodontal disease, or misalignment should be made as early as possible. The removal of tori or exostoses is planned if it appears that they will interfere with the design or wearing of the RPD. Enlarged maxillary tuberosities are surgically reduced if they extend below the desired plane of occlusion or if they interfere with the placement of the maxillary or mandibular denture bases.

  Other surgical procedures occasionally indicated may include frenectomy, modifica-

tion of high muscle attachments, or excision of flabby tissue from the edentulous residual ridges.

- Oral hygiene and plaque control instruction: The effective control of dental plaque is one of the most significant factors in the success of RPD treatment. The need for plaque control instruction varies widely among patients, but early emphasis on this aspect of treatment, when it is indicated, is desirable. The response of the patient to this instruction will often influence the course of treatment.
- Periodontal treatment: The periodontal health of the retained teeth is one of the most critical considerations, so periodontal therapy, when required, must be given high priority. The goals for periodontal therapy include the elimination of deep periodontal pockets, the elimination of infection and inflammation, and the restoration of optimal gingival architecture. The preservation or provision of an adequate zone of attached gingiva around all abutment teeth is also desired.
- Endodontic therapy: When indicated, endodontic procedures are usually planned so that they may be done simultaneously with the surgical and periodontal procedures. Both pulpal and periapical lesions may be treated routinely. Teeth that have been successfully treated endodontically may be used as RPD abutments if they meet the criteria listed previously.
- Occlusal equilibration: Premature centric contacts, deflective occlusal contacts, or undesirable slides during closure should be eliminated before restorative dentistry procedures are performed so as to avoid reproducing the abnormal occlusion pattern in the restorations. In practice, definitive selective grinding for patients with long-standing malocclusions must often be accomplished in stages, as functional occluding surfaces are restored and the jaw is allowed to revert to more normal patterns of function. Several adjustments may be necessary over the course of treatment.
- Operative dentistry procedures: One of the primary factors for the dentist to consider when planning restorative dental treatment is the importance of achieving a reasonably straight, even occlusal plane. It is nearly impossible to eliminate traumatic contacts during functional movements of the jaw if an irregular occlusal plane is preserved. Treatment with an RPD that has an occlusal table that is “swaybacked” to accommodate opposing extruded or malpositioned teeth is a compromise that usually leads to failure of the treatment. For this reason, cast restorations are frequently required in order to restore a proper plane of occlusion. Sometimes when existing cast restorations are retained it may be necessary to modify the opposing RPD. The restoration of RPD abutment teeth with cast metal or porcelain-fused-to-metal crowns is frequently indicated. The contours and anatomic features of abutment castings are critical to the success of prosthodontic treatment.

  The RPD design should be established and recorded on the mounted diagnostic cast before any abutment crown preparations are made. This is a very important concept, based on the principle that the dentist must know in advance where the rest seats and guide planes will be placed in order to create adequate space for these features during tooth reduction. For example, extra occlusal reduction is required in areas where rest seats are to be placed in order to allow for an adequate thickness of metal under the rest seats.

  All carious lesions must, of course, be treated and restored before the construction of an RPD is started. The use of silver amalgam restorations in abutment teeth is generally accepted, provided that modern, high-strength alloys are used. Existing silver amalgam restorations that have seen years of service should be examined critically if they are present in abutment teeth. Replacement of old restorations is usually indicated if rest seat preparation will involve the restorations.
- Modifications to natural tooth surfaces: The preparation of the natural teeth for reception of an RPD follows in sequence in the treat-

ment plan. Guide planes and rest seats are the usual modifications to be considered. The artificial creation of undercuts and the reduction of undesirable undercuts are other alterations to teeth that may be planned. These procedures are described in detail in chapter 5. Again, it is emphasized that the dentist must be guided in these modifications by the design that has been established on the diagnostic cast during the planning phase of treatment.

### *Importance of a written treatment plan*

A sequential list of all of the anticipated clinical treatment procedures, culminating with the completion of the prosthodontic treatment, should be outlined in writing. A written treatment plan enables the dentist to

**Importance of a Written Treatment Plan**

1. Plan the amount of time and appointment schedule necessary for the treatment and provide this information to the patient.
2. Accurately estimate the professional fees for the treatment.
3. Coordinate the schedule for dental laboratory procedures with the patient's clinical appointments.
4. Provide the patient with a copy of the treatment plan (this is an advisable practice in all cases in which misunderstandings could occur).
5. Meet the legal requirements of informed consent.

Occasionally, modifications to the treatment plan will become necessary as treatment progresses. It is important that notes of these changes be added as supplements to the original treatment plan record in order to prevent later misunderstandings.

## Presentation of the treatment plan

The treatment plan prepared for presentation to the patient should describe the therapy that, in the judgment of the dentist, best meets the needs of the patient. The goals to be sought are the preservation of the remaining teeth and oral tissues, restoration of the best obtainable function and appearance with an RPD, and the maintenance of maximum comfort.

The course of treatment and the results that can realistically be expected should be explained as completely as possible. Visual aids, including diagnostic casts, pictures, and radiographs, can be used freely in helping the patient to understand the goals and the possibilities of treatment. Estimates of the time and costs involved should be given clearly. The patient should be encouraged to ask questions, because the better the patient understands the treatment, the easier it will be for him or her to accept it.

Alternative treatment plans are necessary in some situations. Adequate, if less than optimal, treatment may be considered because of factors such as age, limited finances, or the patient's personal desires. It is the patient's decision to accept or reject any of the plans presented once he or she has been fully informed of the choices. Even in "ideal" plans of treatment, compromises are sometimes necessary. The patient must be informed of the limitations of treatment that result from the patient's own health and oral conditions.

In the discussions of the proposed treatment and its results, enthusiasm, optimism, and encouragement should be shared. Even salesmanship has an effective and proper role, but the dentist must be careful not to give over-enthusiastic promises or guarantees of success. The dentist must emphasize in a kind and positive manner that the success of the treatment is as much a responsibility of the patient as it is of the dentist.

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# 3 Decision Making in RPD Design

## 3.1 Principles of design

There are many different acceptable removable partial denture (RPD) design philosophies. Although they all have distinct theoretical differences to their designs, they also have many similarities. The key to a successful removable partial denture, regardless of the philosophy that you use, is to strictly adhere to that philosophy when designing the RPD framework.

Regardless of the design philosophy one prescribes to, there are certain aspects that are common to all designs. The components that comprise a removable partial denture framework are the clasp assembly, indirect retention, major connector, minor connector, and physical retention. In addition, denture teeth and denture acrylic resin may be incorporated into the final prosthesis. In this chapter the discussion will be limited to the framework itself and will not discuss the theoretical biomechanical design philosophies. Rather, this chapter will compare and contrast two of the most commonly used design philosophies—the broad stress distribution and the RPI (mesical rest, distal guide plate, I-bar retainer)—from a clinical standpoint of evaluating a cast and developing the framework design.

The *clasp assembly* is that part of an RPD that acts as a direct retainer to prevent dislodgement by encompassing and contacting an abutment tooth. It is composed of a rest, a retentive arm, proximal plate, and bracing component(s) (Figures 3.1.1a–c). There are six factors that are required of a clasp assembly:

1. Retention: Provides resistance to vertical dislodgement.
2. Stability: Provides resistance to horizontal forces.
3. Support: Provides resistance to vertical seating.
4. Reciprocation: Provides resistance to horizontal forces exerted on a tooth by an active retentive clasp.
5. Encirclement: Engages the tooth greater than 180° to prevent horizontal tooth movement from within the confines of a clasp assembly.
6. Passivity: Puts no active force on a tooth when a clasp is in place.

The purpose of *indirect retention* is to resist rotation around the fulcrum line and to provide support and stability of the removable partial denture. It is able to accomplish this by (1) preventing movement of the denture base away from the ridge, (2) reducing tilting leverage on the abutment teeth (reducing rotation), (3) stabilizing the RPD against lateral movement, and (4) providing a positive seat for support. The

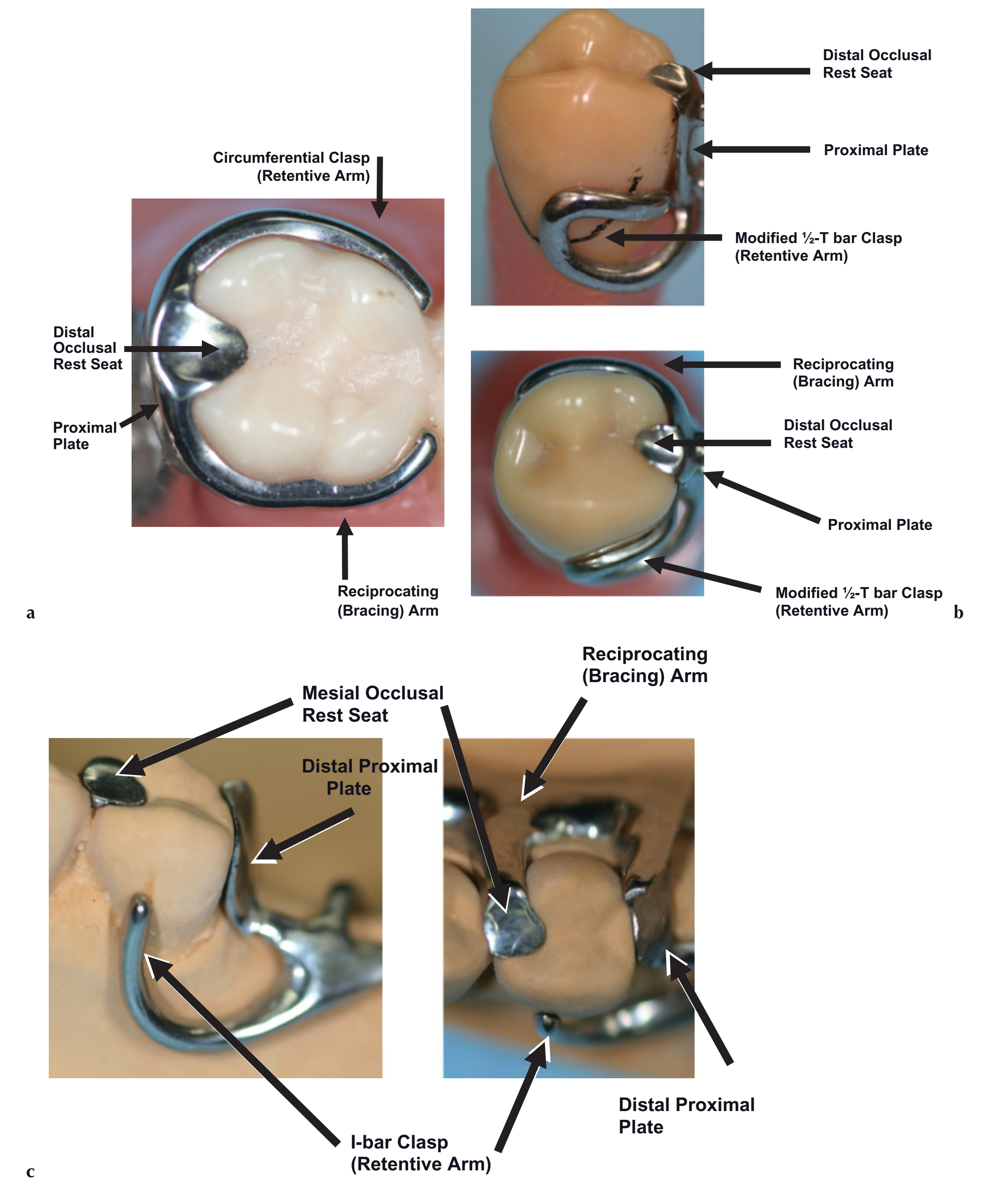


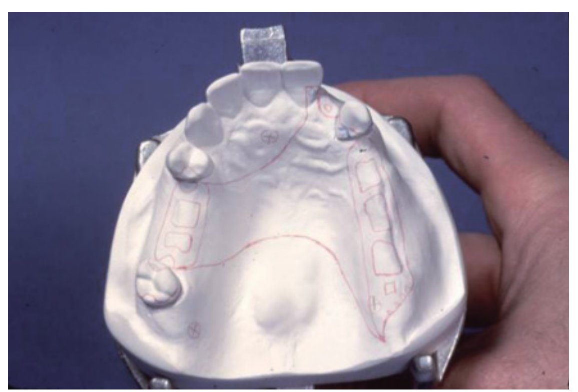

**Figure 3.1.1.** a. Photo showing detailed aspects that comprise a circumferential clasp assembly. b. Photo showing detailed aspects of a modified 1/2-T clasp assembly, buccal and occlusal views. c. Photo showing detailed aspects of an RPI I-bar clasp assembly.

indirect retainer may also aid in providing a positive seat for relining and rebasing procedures.

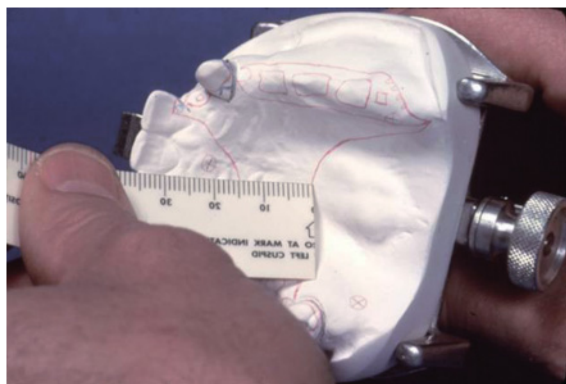
The *major connector* joins the components of the removable partial denture on one side of the arch to those on the contralateral side (Figures 3.1.2a–c). It should be rigid with minimal bulk. It should not impinge on the gingival tissues. In an effort to avoid gingival tissue impingement, guidelines have been established with regard to location of the free gingival margin. In the maxilla, the metal margins of the major connector should be at least 6 mm from the free gingival margin. In the mandible, the lingual bar should be at least 3 mm below the free gingival margin with the width of the bar being 5 mm. Therefore, there needs to be a minimum of 8 mm below the free gingival margin in order to use a lingual bar as the major connector for any given patient.

In its simplest terms, the *minor connector* links the major connector or base of the removable partial denture to the other components of the removable partial denture. It joins the clasp assembly to the major connector, the indirect retainers or auxiliary rests to the major connector, and the denture base to the major connector.

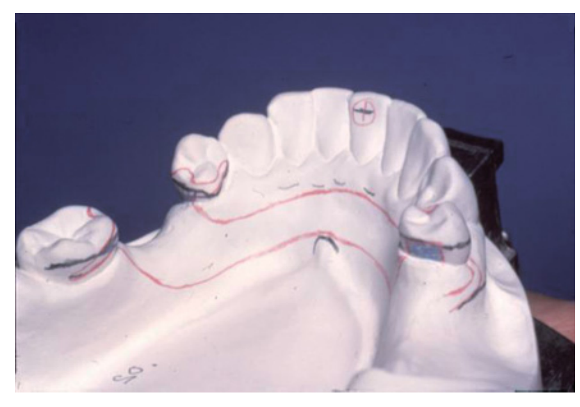
The *physical retention* is the part of the framework to which the denture resin base is attached. There are three basic types of physical retention: latticework, meshwork, and posts (nailheads), loops, wire, or beads attached to a metal base. (Figures 3.1.3a–d) There are three major requirements of the physical retention: It must be rigid; it must have adequate strength to resist breakage; and it must not interfere with the tooth arrangement. The purpose of the physical retention is to



a



b



c

**Figure 3.1.2.** a and b. Maxillary major connector (illustrating connection of componentry and location relative to the free gingival margin). c. Mandibular major connector (illustrating connection of componentry and location with regard to the free gingival margin).



**Figures 3.1.3a–d.** Photos illustrating the three basic types of physical retentions. (a) Latticework. (b) Meshwork. (c) Metal base with bead retention. (d) Metal base with post.

1. Support the teeth.
2. Transmit occlusal load to underlying bone.
3. Resist lateral movement.
4. Resist movement toward the residual ridge.
5. Stimulate the tissues of the residual ridge.
6. Improve esthetics.

Evaluation of a patient for a removable partial denture is most easily accomplished using diagnostic casts. The cast should be of good quality regardless of whether a cast is to be used for diagnostic purposes or to fabricate a definitive prosthesis. The diagnostic cast should accurately record the anatomic form of the teeth, surrounding structures, and mucosal tissue. When evaluating a cast it should be free of voids and positives and have accurate detail and adequate extension in soft-tissue areas in order to evaluate the proper contours of teeth for framework support and soft tissues for denture base extensions.

In the maxilla the following landmarks should be captured: residual alveolar ridges, rugae, maxillary tuberosity, labial vestibule, buccal vestibule, pterygomaxillary notch, buccal frenum, labial frenum, vibrating line (Figure 3.1.4). Similarly, the relevant landmarks in the mandible are buccal shelf, residual alveolar ridge, labial vestibule, buccal vestibule, lingual frenum, retromolar pad, retromylohyoid fossa, aveololingual sulcus, buccal frenum, labial frenum (Figure 3.1.5).

Diagnostic cast evaluations of hard and soft tissues aid in the determination of patient needs. During the evaluation of the remaining teeth,

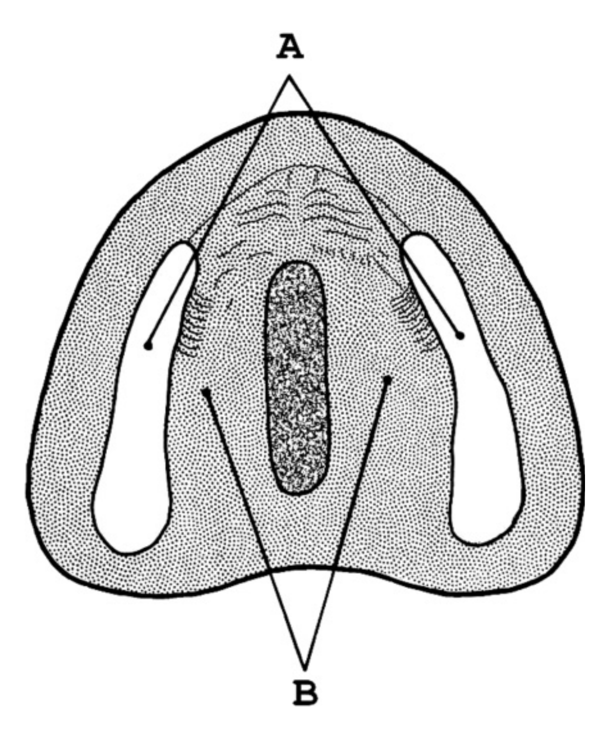



**Figure 3.1.4.** Primary edentulous support areas of the maxilla. (A) Posterior residual ridge areas. (B) Horizontal part of the palate. Although this diagram depicts an edentulous maxillary cast, an RPD patient will have similar partially edentulous areas that will be primary support for the denture base area(s) or extensions.

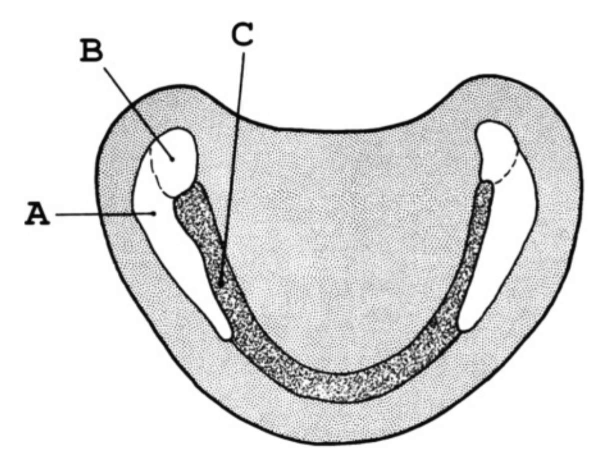



**Figure 3.1.5.** Primary edentulous support areas of the mandible. (A) Buccal shelf area. (B) Retromolar pad—depending on tissue consistency. (C) Slopes of residual ridge as secondary support. Although this diagram depicts an edentulous mandibular cast, an RPD patient will have similar partially edentulous areas that will be primary or secondary support for the denture base area(s) or extensions.

one may determine the need for recontouring of the teeth or for restorations on the teeth to be used as abutments for the removable partial denture. Evaluation may identify occlusal discrepancies that may lead to the need for additional treatment due to inadequate interarch space or malpositioned teeth. Tuberosity interferences, for example, may require preprosthetic surgery.

When evaluating a patient for a removable partial denture, one must evaluate the patient's occlusion to determine if there are any limiting occlusal considerations that may determine which design philosophy will work best for that particular patient. Two primary examples with regard to this point are patients with deep vertical overlap, which will hinder the dentist's ability to place lingual plating along the maxillary anterior teeth, and strong tight posterior occlusal contacts in the distal fossa of a potential abutment tooth. The former may lead one to either lowering the position of the plating or selecting a major connector that does not require plating that area; for example, an anteroposterior palatal strap. The latter may steer the dentist toward an RPI design philosophy versus a broad stress distribution design.

Using the Kennedy Classification system for organization can simplify your design process. When beginning to design an RPD, one must first identify the Kennedy Classification of the partially edentulous arch. Tables 3.1.1 and 3.1.2 illustrate the principal components and locations by design philosophy based on Kennedy Classification.

Once the Kennedy Classification has been determined, the following questions should be asked:

1. Where are the edentulous modification spaces?
2. Where are the undercuts for the teeth adjacent to these areas?

**Table 3.1.1.** RPI design philosophy.

| Kennedy Classification | Class Assembly | | | | | Indirect Retention Location |
|---|---|---|---|---|---|---|
| | Rest Seat Locations | Direct Retention Location by Tooth | Clasp Preference by Location of Retention | | Modification Spaces | |
| I | Mesioocclusal aspect of tooth adjacent to edentulous area | Most distal abutment tooth (mesial to edentulous space) | **Mid-buccal retention:** 0.01″ undercut *Infrabulge clasp* (I-bar) | **MB retention:** 0.01″ undercut *Suprabulge clasp* (circumferential) | None | Positioned perpendicular to the fulcrum line |
| II | Mesioocclusal aspect of tooth adjacent to edentulous area and adjacent to any other edentulous areas | Most distal abutment tooth (mesial to edentulous space) | **Mid-buccal retention:** 0.01″ undercut *Infrabulge clasp* (I-bar) | **MB retention:** 0.01″ undercut *Suprabulge clasp* (circumferential) | **Modification space exists:** Teeth adjacent to the space should be clasped<br>**No modification space exists**: No additional clasps are required | Positioned perpendicular to the fulcrum line |
| III | Adjacent to edentulous area | Abutment teeth mesial and distal to edentulous space | **Anterior MB retention:** 0.01″ undercut *Suprabulge clasp* (circumferential)<br>**Anterior DB retention:** 0.01″ undercut *Suprabulge clasp* (reverse circumferential) | **Posterior DB retention:** 0.01″ undercut *Suprabulge clasp* (circumferential)<br>**Posterior MB retention:** 0.01″ undercut *Suprabulge clasp* (circumferential) | **Modification space exists:** All (4) teeth adjacent to the space should be clasped<br>**No modification space exists**: A minimum of (1) additional clasp should be used | Direct retainers act as indirect retention |
| IV | Adjacent to edentulous area | Abutment teeth adjacent to edentulous space and (2) clasps as far posterior as possible | Mesiobuccal surface of the most anterior teeth | Bilaterally as far posterior as possible *Suprabulge clasp* (circumferential) | None | Direct retainers act as indirect retention |

**Table 3.1.2.** Broad stress distribution philosophy.

| Kennedy Classification | Class Assembly | | | | | Indirect Retention Location |
|---|---|---|---|---|---|---|
| | Rest Seat Locations | Direct Retention Location by Tooth | Clasp Preference by Location of Retention | | Modification Spaces | |
| I | Adjacent to edentulous area | Most distal abutment tooth (mesial to edentulous space) | **DB retention:** 0.01″ undercut<br>*Infrabulge clasp* (modified 1/2-T) 0.01″ undercut<br>*Suprabulge clasp* (reverse circumferential) | **MB retention:** 0.02″ undercut<br>*Suprabulge clasp* 18-gauge wrought wire | None | Positioned perpendicular to the fulcrum line |
| II | Adjacent to edentulous area | Most distal abutment tooth (mesial to edentulous space) | **DB retention:** 0.01″ undercut<br>*Infrabulge clasp* (modified 1/2-T) 0.01″ undercut<br>*Suprabulge clasp* (reverse circumferential) | **MB retention:** 0.02″ undercut<br>*Suprabulge clasp* 18-gauge wrought wire | **Modification space exists:** Teeth adjacent to the space should be clasped<br>**No modification space exists**: (2) clasps should be used as far anteriorly and posteriorly as possible | Positioned perpendicular to the fulcrum line |
| III | Adjacent to edentulous area | Abutment teeth mesial and distal to edentulous space | **Anterior MB retention:** 0.01″ undercut<br>*Suprabulge clasp* (circumferential)<br>**Anterior DB retention:** 0.01″ undercut<br>*Suprabulge clasp* (reverse circumferential) | **Posterior DB retention:** 0.01″ undercut<br>*Suprabulge clasp* (circumferential)<br>**Posterior MB retention:** 0.01″ undercut<br>*Suprabulge clasp* (circumferential) | **Modification space exists:** All (4) teeth adjacent to the space should be clasped<br>**No modification space exists**: (2) clasps should be used as far anteriorly and posteriorly as possible | Direct retainers act as indirect retention |
| IV | Adjacent to edentulous area | Abutment teeth adjacent to edentulous space | Mesiobuccal surface of the most anterior teeth 0.01″ undercut | Bilaterally as far posterior as possible<br>0.01″ undercut<br>*Suprabulge clasp (circumferential)* | None | Direct retainers act as indirect retention |

3. Where are the soft-tissue undercuts located?
4. Do the abutment teeth or the residual ridge require "protection" from external forces acting on the removable partial denture?
5. Is additional indirect retention required beyond the direct retainers?
6. What type of physical retention is best for the replacement teeth?
7. What major connector best connects the RPD components?
8. What tooth modifications are required for this design?

1. Where are the edentulous modification spaces?

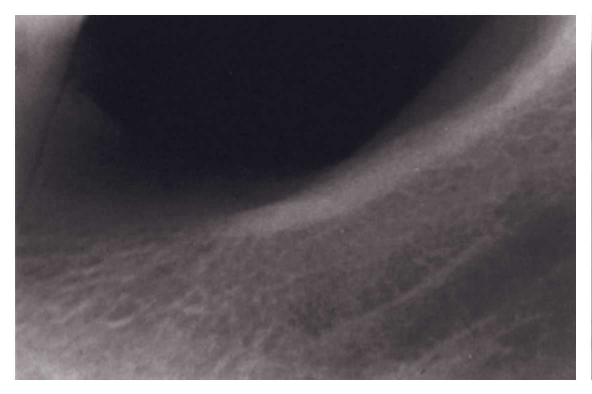
   The location of the edentulous area(s) helps to determine rest seat location, clasp location, and number of clasps needed for the RPD design (see Tables 3.1.1 and 3.1.2).
2. Where are the undercuts for the teeth adjacent to these areas?

   Typically the teeth adjacent to the edentulous areas will be clasped. The location and depth of the undercuts help in selection of the type of clasp.
3. Where are the soft-tissue undercuts located?

   Note the position of the soft-tissue undercuts in order to determine if they will allow for infrabulge or suprabulge clasps.
4. Do the abutment teeth or the residual ridge require "protection" from external forces acting on the removable partial denture?

   Although each design philosophy may have a preferred clasp assembly based upon depth and location of undercuts, determining whether the primary support (tooth or residual ridge) requires any protection from stresses acting upon the RPD can be important in selection of the appropriate clasp. This requires the evaluation of the tooth and residual ridge support quality. Large, well-formed residual ridges can resorb greater amounts of stress by permitting longer denture flanges that stabilize against lateral forces. On the other hand, displaceable residual ridges have decreased vertical support, and therefore there is less lateral stability of the denture base (Figures 3.1.6a and b). This situation would require the abutment tooth to bear more of the external forces applied to it. As with the supporting residual ridge, the support of the abutment tooth must be evaluated with regard to its ability to withstand external forces acting upon it in order to determine the most appropriate clasp design.

   For example, in a Kennedy Class I RPD design, the preferred clasp assembly is an infrabulge clasp modified 1/2-T due to greater



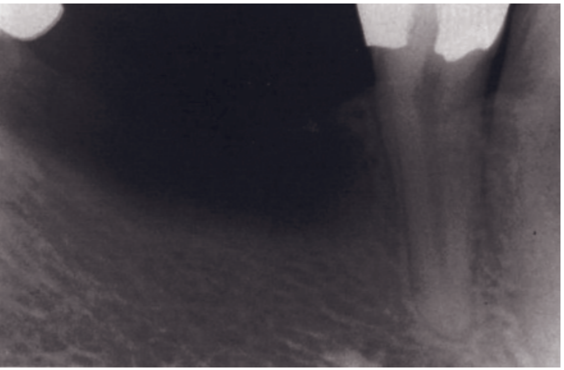




**Figure 3.1.6.** a. Radiograph of distal-extension base area demonstrating absence of cortical bone. This particular example shows an area that has been subjected to stresses generated from RPD use over multiple years. b. Radiograph of edentulous area demonstrating questionable continuity of cortical plate. Anticipate poor support with this type of bone present.





**Figure 3.1.7.** a. The wrought wire, or in this scenario the PGP wire, is adapted closely to the abutment tooth with the terminal one-third of the wire retainer engaged into the undercut. b. The buccal view of the patient in maximum intercuspation shows the position of the wire retainer relative to the tooth surface and gingival tissues.

encirclement of the tooth. However, this is a rigid clasp, and in situations where there is concern regarding the abutment tooth and the need for a more flexible clasp that will transmit less force to the tooth and increase the forces transmitted to the residual ridge for support, an 18-gauge wrought wire clasp into a 0.02″ mesiobuccal undercut would be a better choice (Figures 3.1.7a and b).

5. Is additional indirect retention required beyond the direct retainers?

   In many situations a clasp may act as both a direct and indirect retainer (Figure 3.1.8). Based upon Kennedy Classification, one can determine whether additional indirect retention is required. If indirect retention is needed it is located perpendicular to the fulcrum line. The fulcrum line is determined by a line drawn between the most posterior occlusal rests of the RPD.

6. What type of physical retention is best for the replacement teeth?

   When determining the type of physical retentions the following factors should be evaluated (Table 3.1.3): number of teeth to be replaced, available vertical and lateral space, adjustability of intaglio surface, and need for ability to reline at a later date. In general, latticework is considered to be the physical retention of choice. It may be used for multiple tooth replacements, provides strongest attachment of the acrylic, is the easiest to reline, and allows for adjustment of acrylic in regions that have undercuts and might be difficult to fit otherwise. However, in regions where the space for tooth replacements is limited, a metal base may be a more appropriate choice. This latter choice does have negative consequences. It has the weakest attachment to the acrylic, it is difficult to

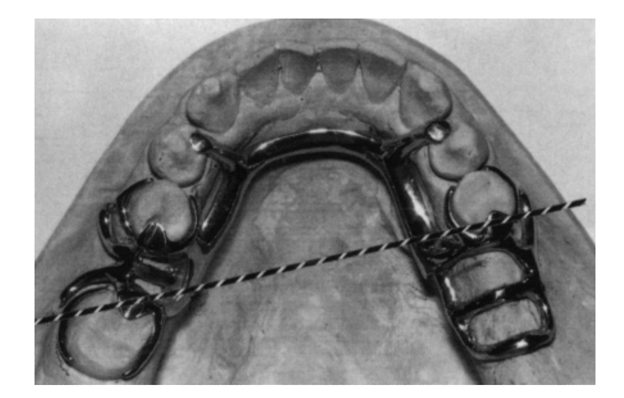


**Figure 3.1.8.** The fulcrum line is shown with the "hatched" wire across the occlusal surface of the cast; the fulcrum passes through the distalmost rest seats on the most posterior abutment teeth on each side. An indirect retainer should be located on the opposite side of the fulcrum line from the distal extension base and positioned at right angles to and as far from the fulcrum line as possible. In this situation, instead of creating unesthetic incisal rest seats on the anterior teeth, the indirect retainers were placed on MO of bilateral first premolars, teeth nos. 21 and 28.

**Table 3.1.3.** Physical retention choices for replacement teeth.

| Type of Physical Retention | Description | Advantages | Disadvantages |
|---|---|---|---|
| Open latticework | Metal struts running over the crest of the ridge | ■ Multiple tooth replacements<br>■ Provides strongest attachment of the acrylic<br>■ Easiest to reline | ■ Vertical space for framework, denture teeth, and acrylic |
| Meshwork | Thin sheet of metal with multiple small holes extending over crest of the ridge | ■ Multiple tooth replacements<br>■ May be relined | ■ Vertical space for framework, denture teeth, and acrylic<br>■ More difficult to pack acrylic; weaker attachment of acrylic |
| Metal base (bead, wire, or nailhead) | Metal denture base with retentive elements (beads, wires, nailheads) that fits directly against the ridge | ■ Single and multiple tooth replacements<br>■ Metal has better tissue response than acrylic<br>■ Requires less vertical space<br>■ Best for tooth-supported RPD | ■ Weakest attachment of the acrylic<br>■ Difficult to adjust the metal base<br>■ Cannot be relined |

adjust the metal base intaglio surface, and it cannot be relined.

7. What major connector best connects the RPD components?

   Once the major components of the RPD have been determined and drawn, the selection of the major connector is easily made by selecting the major connector design that links the components on contralateral sides together. Tables 3.1.4 through 3.1.6 list the advantages and disadvantages to some of the most commonly used major connectors and provide a comparison of rigidity and patient preference of the various designs. Figures 3.1.9a–h illustrate designs using those major connectors.

8. What tooth modifications are required for this design?

   The final evaluation is to determine based on your preliminary design what tooth modifications are required. Assessment of tooth contours should include the need for recontouring the tooth to create undercuts, guide planes, rest seat, and alteration of the height of contour. All these modifications should be determined based on the design requirements of your chosen philosophy (Table 3.1.7).

Using model-patients according to Kennedy Classifications, each model-patient example is used to work through this process following the questions as outlined again below.

1. Where are the edentulous modification spaces?
2. Where are the undercuts for the teeth adjacent to these areas?

   Viewing the cast from the buccal aspect, note the presence or absence of undercuts on the mesiobuccal, mid-buccal, and distobuccal surface of the prospective abutment teeth.

3. Where are the soft-tissue undercuts located?
4. Do the abutment teeth or the residual ridge require "protection" from external forces acting on the removable partial denture?
5. Is additional indirect retention required beyond the direct retainers?
6. What type of physical retention is best for the replacement teeth?
7. What major connector best connects the RPD components? (See Table 3.1.6.)
8. What tooth modifications are required for this design?

**Table 3.1.4.** Comparison of major connectors—maxillary major connectors.

| Maxillary Major Connectors | | |
|---|---|---|
| Type | Advantages | Disadvantages |
| Posterior palatal bar | Rigid | Difficult for patient to adjust to due to bulkiness<br>Provides little vertical support<br>Should be limited to 1–2 tooth replacements<br>Cannot be used with Kennedy Class I or II |
| Anteroposterior palatal bar | Rigid | Provides little vertical support<br>Should not be considered as a first choice<br>May interfere with phonetics in high narrow vaulted palates<br>Lack of comfort |
| Palatal strap | Rigid<br>Great resistance to bending<br>Less bulk<br>Contributes to indirect retention | Patient complaints of palatal coverage<br>Adverse soft tissue reaction; papillary hyperplasia may occur. |
| Anteroposterior palatal strap | Rigid<br>Great resistance to bending<br>Provides good support<br>Strong<br>More open palate | May interfere with phonetics in some patients |
| U-shape | Reasonably short connector<br>Some vertical support<br>Open palate | More flexible; tendency to spread laterally<br>Lack of cross-arch stability<br>May interfere with phonetics |
| Complete palate | Rigid<br>Great resistance to bending<br>Provides good support<br>Strong<br>Contributes to indirect retention | Patient complaints of palatal coverage<br>Adverse soft tissue reaction; papillary hyperplasia may occur.<br>May interfere with phonetics in some patients |

**Table 3.1.5.** Comparison of major connectors—mandibular major connectors.

| Mandibular Major Connectors | | |
|---|---|---|
| Type | Advantages | Disadvantages |
| Lingual bar | Simplest<br>Most accurate<br>Minimal contact with soft tissues<br>Does not contact teeth | |
| Lingual plate | Most rigid<br>Provides most support<br>May provide indirect retention<br>Provides splinting of teeth<br>Insufficient space for lingual bar<br>Mandibular tori | Extensive coverage of teeth and soft tissues<br>Oral hygiene |

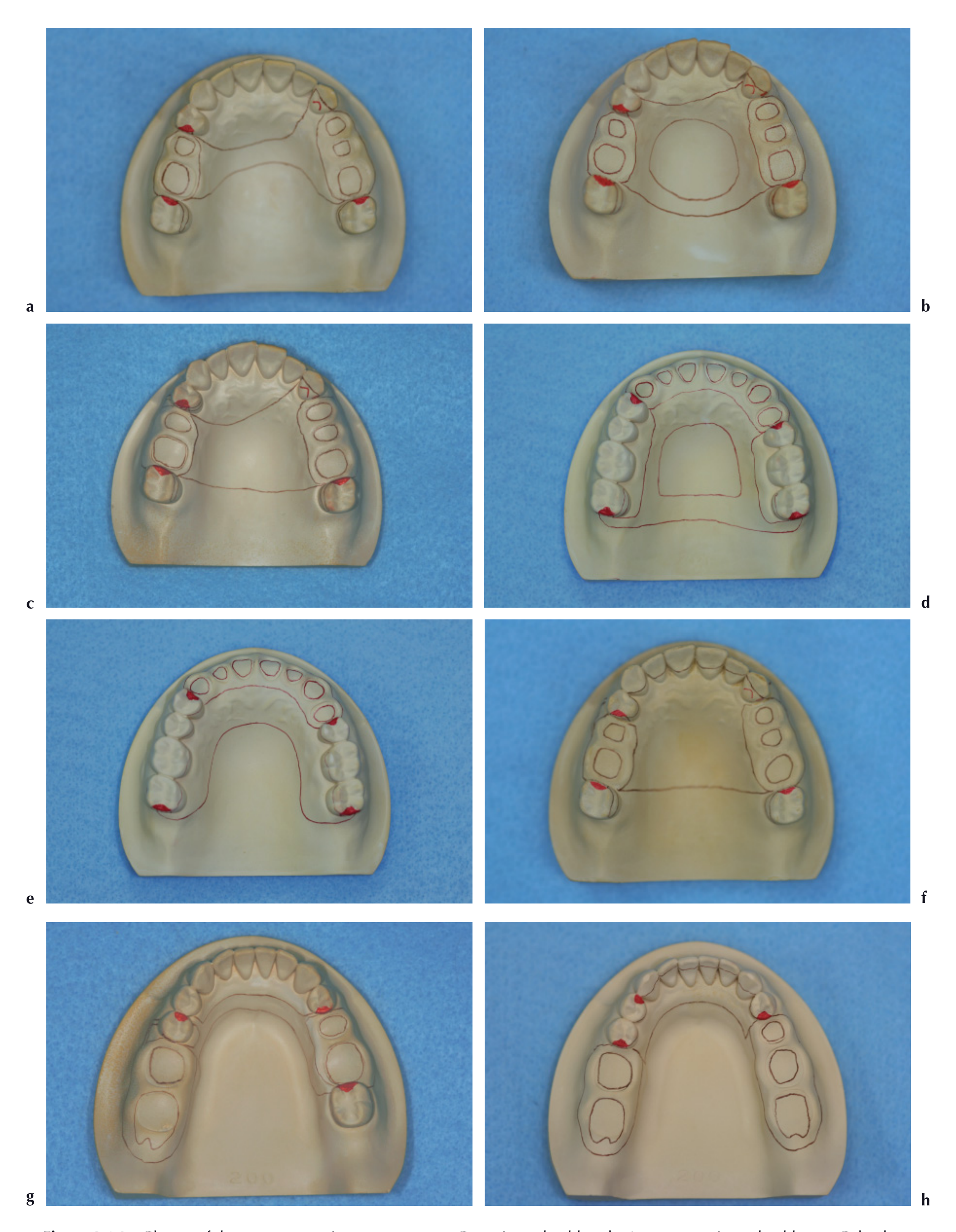



**Figure 3.1.9.** Photos of the common major connectors: a. Posterior palatal bar. b. Anteroposterior palatal bar. c. Palatal strap. d. Anteroposterior palatal strap. e. U-shape. f. Complete palate. g. Lingual bar. h. Lingual plate.

**Table 3.1.6.** Comparison of rigidity versus patient preference of major connector design.

| Major Connector | Rigidity Ranking† | Patient Preference† |
|---|---|---|
| **Maxillary** | | |
| Broad posterior palatal strap | 2 | 1 |
| Anteroposterior palatal strap, no plating of anterior teeth | 3 | 2 |
| Anteroposterior palatal strap, no plating of anterior teeth | 1 | 3 |
| Complete palatal coverage | | 4 |
| U-shape | 4 | |
| **Mandibular** | | |
| Lingual bar | 1 | 1 |
| Lingual plating | 2 | 2 |

†1 = highest ranking.

**Table 3.1.7.** Comparison of removable partial denture philosophies in a Kennedy Class I.

| | Broad Stress Distribution | RPI |
|---|---|---|
| Rest seat location | Adjacent to edentulous area (DO or cingulum rests) | MO or cingulum rest |
| First choice of clasp | DB 0.01″ undercut: Modified 1/2-T bar | Mid-buccal 0.01″ undercut: I-bar |
| | MB 0.02″ undercut: Wrought wire | MB 0.01″ undercut: Circumferential |
| Guide planes | 1.5 mm in height occlusogingivally | 2–3 mm in height occlusogingivally |
| Reciprocation | Reciprocating arm | Minor connector |

## RELATED REFERENCE READING

Ben-Ur, Z., Matalon, S., Aviv, I., Cardash, H.S. 1989. Rigidity of major connectors when subjected to bending and torsion. *J Prosthet Dent* 62(5): 557–562.

Campbell, L.D. 1977. Subjective reactions to major connector designs for removable partial dentures. *J Prosthet Dent* 37(5):507–516.

## 3.2 Kennedy Class I analysis and design

Using the patient in Figure 3.2.1 for an example of analysis and design for a Kennedy Class I clinical scenario, work through the process of designing a removable partial denture by answering the following questions.

## Kennedy Class I

1. Are there any limiting occlusal considerations?
2. Where are the edentulous modification spaces?
3. Where are the undercuts for the teeth adjacent to these areas?
4. Where are the soft-tissue undercuts located?
5. Do the abutment teeth or the residual ridge require "protection" from external forces acting on the removable partial denture?
6. Is additional indirect retention required beyond the direct retainers?
7. What type of physical retention is best for the replacement teeth?
8. What major connector best connects the RPD components? (See Tables 3.1.4–3.1.6.)

9. What tooth modifications are required for this design?

1. Are there any limiting occlusal considerations?

   There are no limiting occlusal considerations; either RPD design philosophy may be used. Therefore, we will design the cast using the broad stress distribution philosophy followed by the RPI design philosophy (Figures 3.2.2a–c).
2. Where are the edentulous modification spaces?

   The white arrows (Figure 3.2.3) indicate the edentulous areas. Based on the broad stress distribution philosophy, determine where the rest seats should be placed using Table 3.1.2.

   The rest seats are drawn on the teeth adjacent to the edentulous areas. Note the position of the red-colored rest seat drawn on the cast in Figures 3.2.4a and b.
3. Where are the undercuts for the teeth adjacent to these areas?

   Note the presence of an undercut on the mesiobuccal surface, and the absence of undercut on the distobuccal surface of the prospective abutment tooth no. 20 (Figures 3.2.5a and b).

   Note the presence of an undercut on the mesiobuccal surface, and the absence of undercut on the distobuccal surface of the prospective abutment tooth no. 28 (Figures 3.2.6a and b).

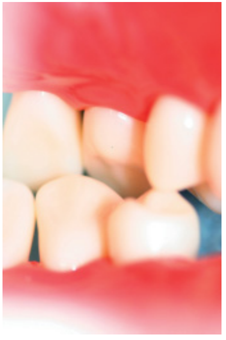
   Using the broad stress distribution philosophy, this will lead you to select a wrought wire clasp for both tooth no. 20 and no. 28.
4. Where are the soft-tissue undercuts located?

   Note the position of the soft-tissue undercuts in order to determine if they will allow for infrabulge or suprabulge clasps. Although there are no soft-tissue undercuts of significance around tooth no. 20 or no. 28 that present problems for an infrabulge clasp, a suprabulge clasp is needed due to the position




**Figure 3.2.1.** Occlusal view of mandibular model of a patient.


a


b


c

**Figures 3.2.2a–c.** Intraoral view of patient's occlusion depicting maximum intercuspation.

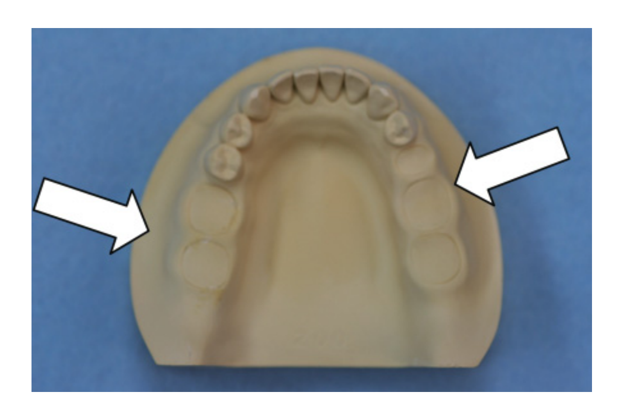
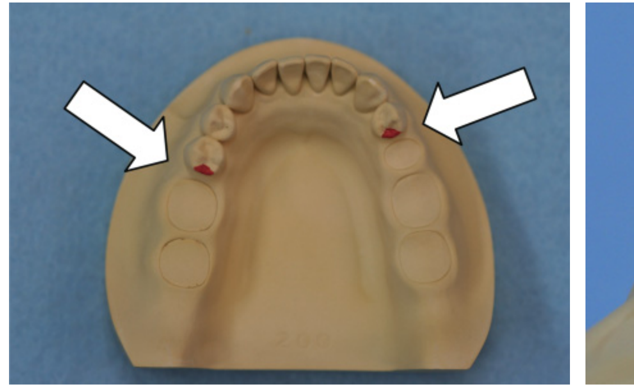


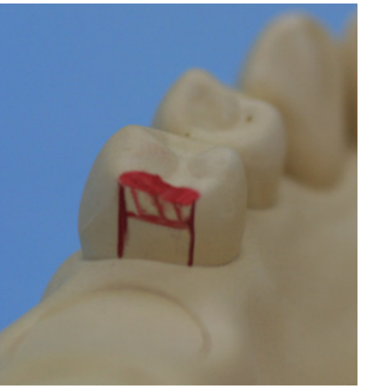
**Figure 3.2.3.** Occlusal view of patient's mandibular cast.

of the undercut on the tooth (Figures 3.2.7a and b).

5. Do the abutment teeth or the residual ridge require "protection" from external forces acting on the removable partial denture?

This information is obtained from the oral examination findings. A Kennedy Class I removable partial denture design is both tooth and soft-tissue borne. If there are periodontal considerations with regard to the stability of the tooth, a more flexible clasp such as a wrought wire clasp will be kinder to the tooth, but will require more support from the soft tissue. Remember, the location





**Figures 3.2.4.** (a) Occlusal view of mandibular cast with rest seats drawn on the DO on no. 20; DO on no. 28. (b) Proximal view of MO on no. 20; red hash marks represent position on the proximal surface that will be modified to create guide planes.





**Figures 3.2.5a and b.** View of the cast from the buccal aspect of tooth no. 20 and no. 28.



**Figures 3.2.6a and b.** View of the cast from the buccal aspect of tooth no. 28.

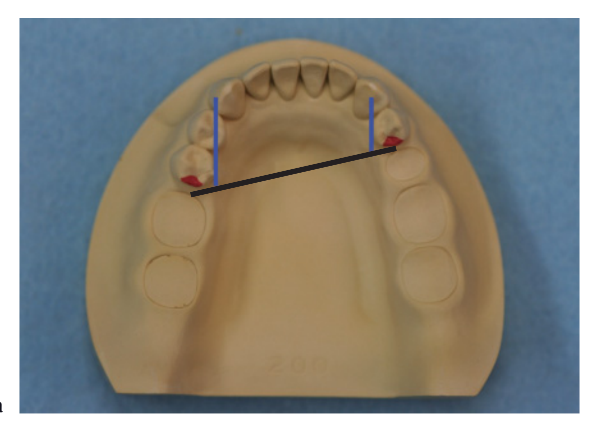


**Figures 3.2.7a and b.** Bilateral buccal views of soft- and hard-tissue contours represented on the cast.

of the undercut will be the deciding factor with regard to clasp choice. Assuming for this patient that his or her periodontal status is healthy, a wrought wire (suprabulge) clasp is the clasp of choice for tooth no. 20 and no. 28 due to the mesiobuccal undercut.

6. Is additional indirect retention required beyond the direct retainers?

   Based upon Kennedy Classification of Class I for the broad stress distribution philosophy, additional indirect retention is recommended. The indirect retention should be positioned perpendicular to the fulcrum line. Remember, the fulcrum line is determined by a line drawn between the most posterior occlusal rests of the RPD (shown in black; Figure 3.2.8a). The blue lines drawn perpendicular to the fulcrum line (Figure 3.2.8b) represent possible locations for indirect retention. Rest seats may be placed on either the mandibular first premolar (no. 21) or the mandibular canines (no. 22 or no. 27). Rest seats do not need to be placed bilaterally in order to provide sufficient indirect retention. Given the option of placing a rest seat on the mesial of the first premolar versus a canine, selection of the premolar would be more appropriate. This option avoids the use of an





**Figures 3.2.8.** Occlusal views of mandibular cast. (a) Line drawn between the two distalmost rest seats representing the fulcrum line and perpendicular lines representing potential positions of indirect retention needed. (b) Design drawing with additional indirect rest seat drawn on the mesioocclusal of tooth no. 21.





**Figures 3.2.9.** View of interocclusal/interarch space. (a) Right side. (b) Left side.

unesthetic incisal rest seat or placing composite on the lingual aspect of the canine in order to create a cingulum rest.

7. What type of physical retention is best for the replacement teeth?

   Since latticework is considered the physical retention of choice for replacement of multiple teeth, the determination is made based on the inability to use this type of physical retention. If the lack of vertical space is not a limiting factor, then latticework should be selected (Figures 3.2.9a and b and Figure 3.2.10).

8. What major connector best connects the RPD components? (See Tables 3.1.4–3.1.6.)



**Figure 3.2.10.** Physical retention—latticework—drawn on the preliminary cast.

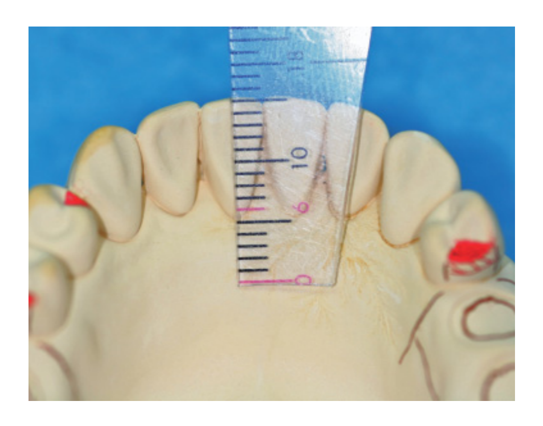
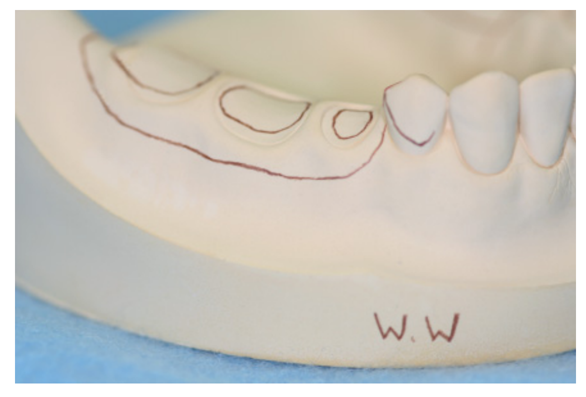



**Figure 3.2.11.** View of lingual aspect of mandibular anterior teeth (measuring available space from the free gingival margin to the depth of the lingual vestibule).



**Figure 3.2.12.** Photo of the proposed RPD design.







**Figures 3.2.13a and b.** Buccal views of clasp positions.

In the mandible, a minimum of 8 mm below the free gingival margin is required in order to use a lingual bar, the mandibular major connector of choice, as the major connector. Based on the clinical inspection as well as the cast, there is not enough available space to meet this requirement (Figure 3.2.11). Therefore, a lingual plate should be selected as the major connector.

9. What tooth modifications are required for this design?

The tooth modifications needed based on this proposed design are bilateral distal occlusal rest seats and distal guide planes on teeth no. 20 and no. 28, and a mesial occlusal rest seat on tooth no. 21 (Figure 3.2.12).

When prescribing a wrought wire clasp it is customary to write the abbreviation "W.W." on the base of the cast directly below the tooth to receive this clasp design. This helps the laboratory technician distinguish the prescribed clasp design from a poorly drawn cast clasp (Figures 3.2.13a and b).

## RPI design philosophy

The analysis and design of a removable partial denture following the RPI design philosophy are described following the questions as outlined in section 3.3, "Kennedy Class II Analysis and Design." The RPI design philosophy can be utilized with each of the Kennedy Classifications I through IV and meets all criteria fundamental to RPD success. In many instances, the use of the I-bar clasp design can meet esthetic demands in the anterior region when compared to a circumferential clasp or a T or modified 1/2-T clasp.

## 3.3 Kennedy Class II analysis and design

Using the patient in Figure 3.3.1, work through the process of designing a removable partial denture by answering the following questions.

## Kennedy Class II

1. Are there any limiting occlusal considerations?
2. Where are the edentulous modification spaces?
3. Where are the undercuts for the teeth adjacent to these areas?




**Figure 3.3.1.** Occlusal view of mandibular model of a patient.

Viewing the cast from the buccal aspect, note the presence or absence of undercuts on the mesiobuccal, mid-buccal, and distobuccal surface of the prospective abutment teeth.

4. Where are the soft-tissue undercuts located?
5. Do the abutment teeth or the residual ridge require "protection" from external forces acting on the removable partial denture?
6. Is additional indirect retention required beyond the direct retainers?
7. What type of physical retention is best for the replacement teeth?
8. What major connector best connects the RPD components? (See Tables 3.1.4–3.1.6.)
9. What tooth modifications are required for this design?

1. Are there any limiting occlusal considerations?

   There are no limiting occlusal considerations (Figures 3.3.2a–c); either RPD design philosophy may be used. Therefore, we will first design the cast using the broad stress distribution philosophy followed by the RPI design philosophy.
2. Where are the edentulous modification spaces?

   In Figure 3.3.3, white arrows indicate the edentulous areas. Based on the broad stress distribution philosophy, determine where the rest seats should be placed using Table 3.1.2.

   The rest seats are drawn on the teeth adjacent to the edentulous areas. Note the positions of the red-colored rest seats drawn on the cast in Figures 3.3.4a and b.
3. Where are the undercuts for the teeth adjacent to these areas?

   Note the presence or absence of undercuts on the mesiobuccal, mid-buccal, and distobuccal surface of the prospective abutment teeth (Figures 3.3.5a and b).

   There appear to be undercuts on both the mesiobuccal and distobuccal of tooth no. 20. This will allow you to select either a wrought wire clasp or a modified 1/2-T. The determining factors of which type of clasp will be used are based on the presence of soft-tissue

a b c

**Figures 3.3.2a–c.** Intraoral view of patient's occlusion depicting maximum intercuspation.

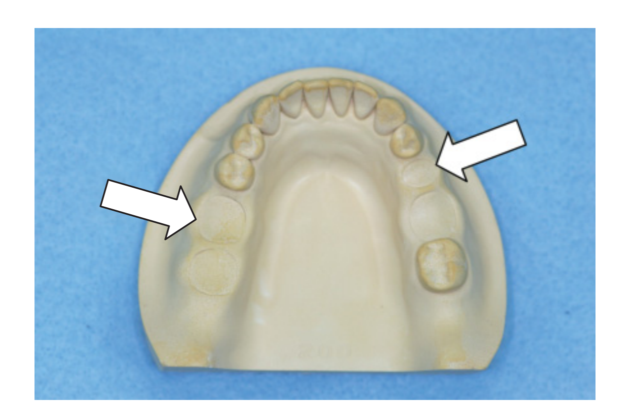
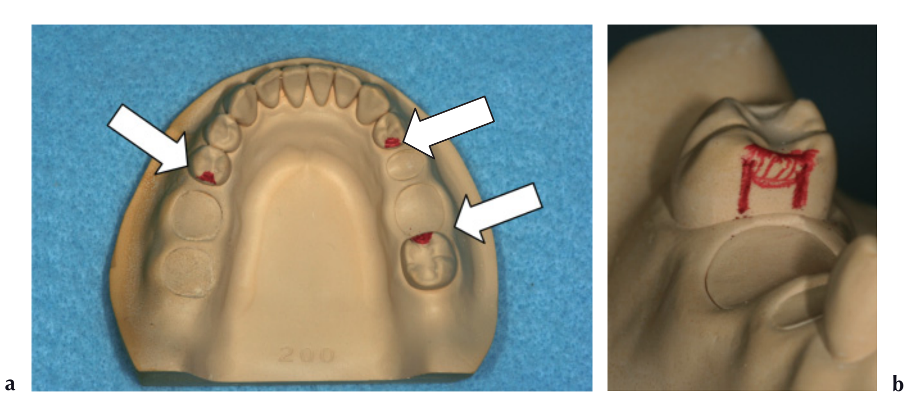


**Figure 3.3.3.** Occlusal view of patient's mandibular cast.

undercuts and the status of supporting structures (questions no. 4 and no. 5).

Note the presence or absence of undercuts on the mesiobuccal, mid-buccal, and distobuccal surface of the prospective abutment teeth (Figures 3.3.6a–d).

Tooth no. 28 appears to have both mesiobuccal and distobuccal undercuts. Tooth no. 31 is tilted slightly to the mesial. It is quite evident that there is an undercut on the mesiobuccal of the tooth; it is not so clear that there is one on the distal of the tooth. Remember, although you may not be using a surveyor in this design process, your laboratory technician will use a surveyor during the fabrication process so the position of the undercut will be verified. If there is not an undercut of the distal, at this point there are three options: design the removable partial denture using the mesial undercut, evaluate the distolingual of the tooth for an undercut, or create an undercut on the distobuccal surface of tooth no. 31.



**Figures 3.3.4.** (a) Photo of mandibular cast with rest seat drawn on the DO on no. 20, DO on no. 28, and MO on no. 31. (b) Proximal view of MO on no. 31; red hash marks represent position on the proximal surface that will be modified to create guide planes.



**Figures 3.3.5a and b.** View of the cast from the buccal aspect of tooth no. 20.

4. Where are the soft-tissue undercuts located?
   Note the position of the soft-tissue undercuts in order to determine if they will allow for infrabulge or suprabulge clasps (Figures 3.3.7a and b). There are no undercuts of significance around tooth no. 20; however, there is an undercut close to the cervical of tooth no. 28 that presents problems for an infrabulge clasp.
5. Do the abutment teeth or the residual ridge require "protection" from external forces acting on the removable partial denture?

This information is obtained from the oral examination findings. An infrabulge clasp is the clasp of choice when there is an adequate space above the soft-tissue undercut and there are no periodontal considerations due to its 180° encirclement. Remember, the location of the undercut will be the deciding factor with regard to clasp choice. Assuming for this patient that his or her periodontal status is healthy, an infrabulge clasp is the clasp of choice for tooth no. 20, while circumferential clasps are chosen for tooth no. 28 and no. 31.

a b

c d

**Figures 3.3.6a–d.** View of the cast from the buccal aspect of tooth no. 28 and no. 31.



a b

**Figures 3.3.7a and b.** Bilateral buccal views of soft- and hard-tissue contours represented on the cast.

The clasp of choice for tooth no. 20 using the broad stress distribution design is the modified 1/2-T.

6. Is additional indirect retention required beyond the direct retainers?

   Based upon Kennedy Classification of Class II for the broad stress distribution philosophy, additional indirect retention is recommended. The indirect retention should be positioned perpendicular to the fulcrum line. Remember, the fulcrum line is determined by a line drawn between the most posterior occlusal rests of the RPD (shown in black; Figures 3.3.8a and b). The blue lines perpendicular to the fulcrum line represent possible locations for indirect retention. Rest seats may be placed on either the mandibular canine, tooth no. 22, or the mandibular first premolar, tooth no. 21.

7. What type of physical retention is best for the replacement teeth?

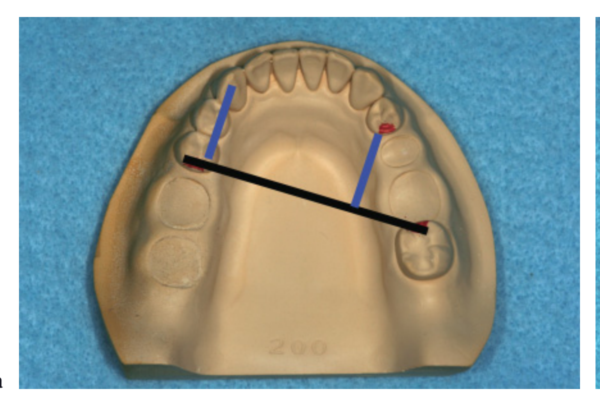
   Since latticework is considered the physical retention of choice for replacement of multiple teeth, the determination is made based on the inability to use this type of physical retention. If the lack of vertical space is not a limiting factor, then latticework should be selected (Figures 3.3.9a–c and Figure 3.3.10).

8. What major connector best connects the RPD components? (See Tables 3.1.4–3.1.6.)

   In the mandible, a minimum of 8 mm below the free gingival margin is required in order to use a lingual bar, the mandibular major connector of choice, as the major connector. Based on the clinical inspection as well as the cast, the available space is greater than the requirement (Figure 3.3.11).

9. What tooth modifications are required for this design?

   The tooth modifications needed based on this proposed design are distal occlusal rest seats and distal guide planes on tooth no. 20 and no. 28, a mesial occlusal rest seat and a mesial guide plane on tooth no. 31, and a rest seat for additional indirect retention on the mesioocclusal of tooth no. 21 (Figure 3.3.12 and Figures 3.3.13a and b).



a



b

**Figure 3.3.8.** Occlusal views of mandibular cast. (a) Line drawn between the two distalmost rest seats representing fulcrum line and perpendicular lines representing potential positions of indirect retention needed. (b) Design drawing with additional indirect rest seats drawn on the mesioocclusal of tooth no. 21.

**Figures 3.3.9.** View of interocclusal/interarch space. (a) Left side. (b) Right side, premolar area. (c) Right side, molar area.

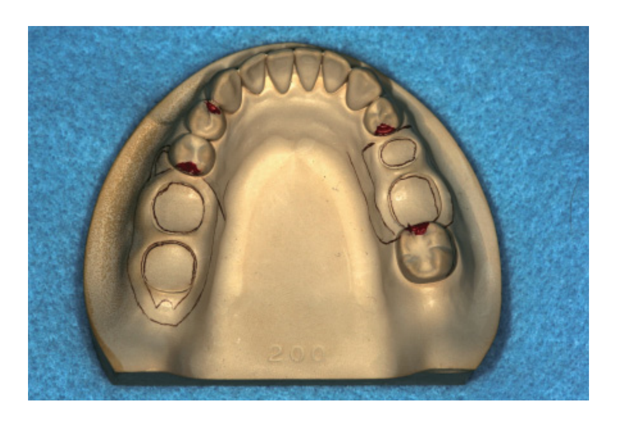


**Figure 3.3.10.** Physical retention—latticework—drawn on the preliminary cast.

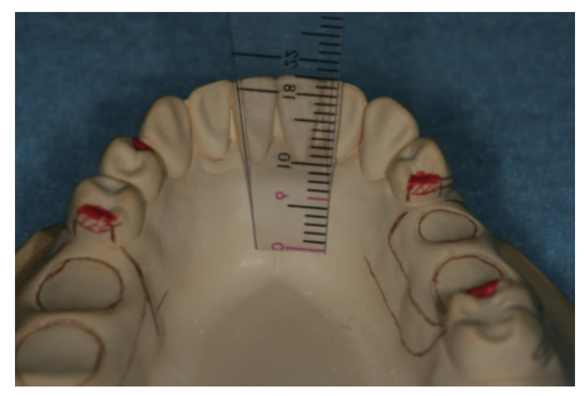


**Figure 3.3.11.** View of lingual aspect of mandibular anterior teeth (measuring available space from the free gingival margin to the depth of the lingual vestibule).

## Repeating analysis using the RPI design philosophy (question numbers 2–9)

2. Where are the edentulous modification spaces?

   The white arrows in Figure 3.3.14 indicate the edentulous areas. Based on the RPI philosophy, determine where the rest seats should be placed using Table 3.1.1.

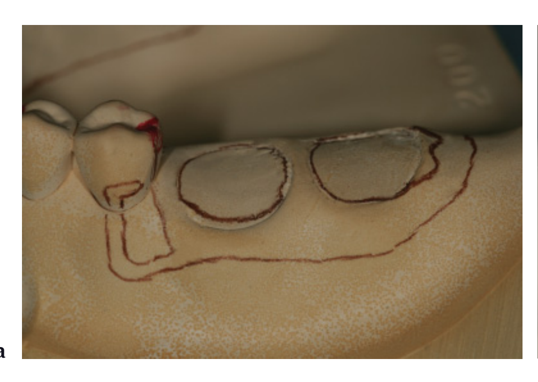
   The rest seats are drawn on the teeth adjacent to the edentulous areas. Note the position of the red rest seat drawn on the cast in Figure 3.3.15. According to the RPI philosophy, the rest is positioned on the mesial of the most distal tooth adjacent to an unbound edentulous space, and adjacent to the edentulous space on the tooth-bound edentulous spaces.

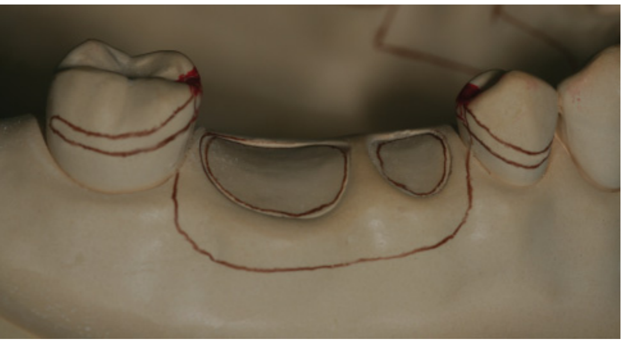
3. Where are the undercuts for the teeth adjacent to these areas?

   Note the presence or absence of undercuts on the mesiobuccal, mid-buccal, and disto-



**Figure 3.3.12.** Photo of the proposed RPD design.





**Figures 3.3.13a and b.** Buccal views of the drawings of clasp and clasp positions.

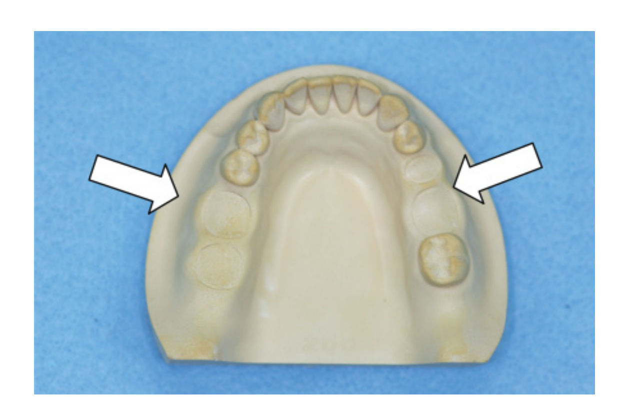


**Figure 3.3.14.** Occlusal view of mandibular cast.

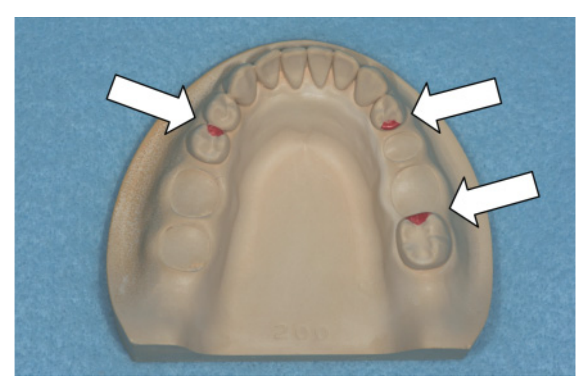
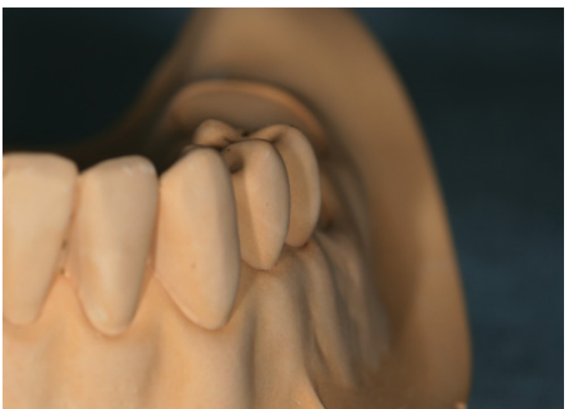


**Figure 3.3.15.** Occlusal view of mandibular cast with rest seats drawn on the MO on no. 20, DO on no. 28, and MO on no. 31.

**Figures 3.3.16a and b.** Views of the cast from the buccal aspect of tooth no. 20.

buccal surface of the prospective abutment teeth (Figures 3.3.16a and b).

There appear to be undercuts on both the mesiobuccal and mid-buccal of tooth no. 20. This will allow you to select either a wrought wire clasp or an I-bar. The determining factors for which type of clasp will be used are based on the presence of soft-tissue undercuts and the status of supporting structures (questions no. 4 and no. 5).

Note the presence or absence of undercuts on the mesiobuccal, mid-buccal, and distobuccal surface of the prospective abutment teeth (Figures 3.3.17a–d).

Tooth no. 28 appears to have both a mesiobuccal and distobuccal undercut. Tooth no. 31 is tilted slightly to the mesial. It is quite evident that there is an undercut on the mesiobuccal of the tooth; it is not so clear that there is one on the distal of the tooth. If there is not an undercut on the distal, at this point there are three options: design the removable partial denture using the mesial undercut, evaluate the distolingual of the tooth for an undercut, or create an undercut on the distobuccal surface of tooth no. 31.

4. Where are the soft-tissue undercuts located?

   Note the position of the soft-tissue undercuts in order to determine if they will allow for infrabulge or suprabulge clasps (Figures 3.3.18a and b). There are no undercuts of significance around tooth no. 20; however, there is an undercut close to the cervical of tooth no. 28, which presents problems for an infrabulge clasp.

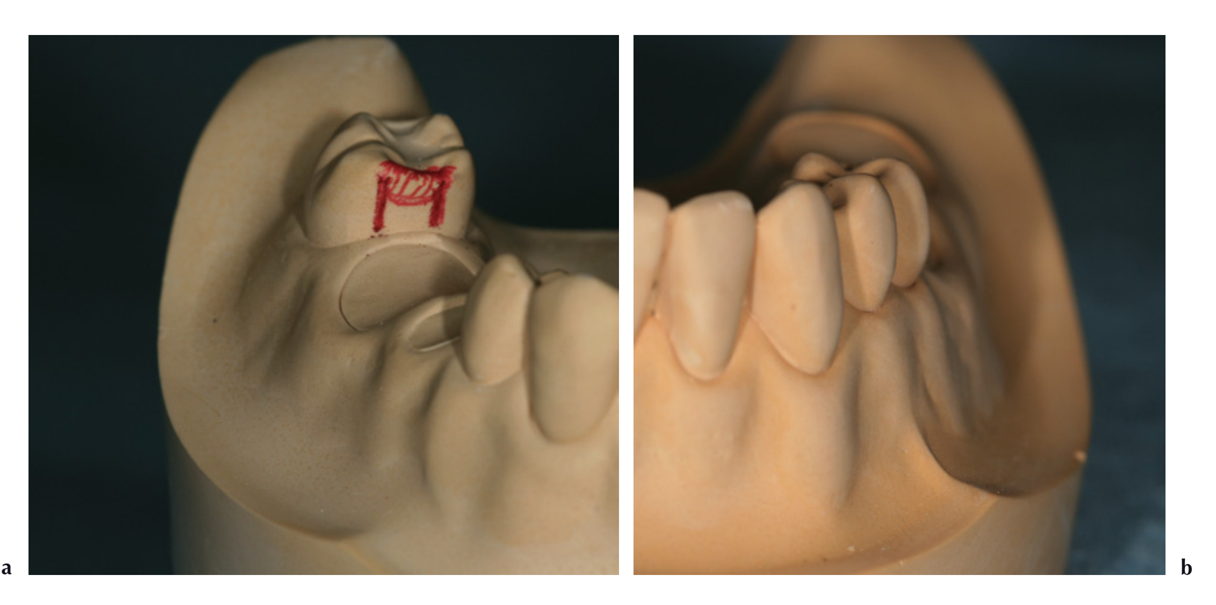
5. Do the abutment teeth or the residual ridge require "protection" from external forces acting on the removable partial denture?

   This information is obtained from the oral examination findings. An infrabulge clasp is the clasp of choice when there is an adequate space above the soft-tissue undercut and there are no periodontal considerations due to its 180° encirclement. Remember, the location of the undercut will be a deciding factor with regard to clasp choice. Assuming for this patient that his or her periodontal status is healthy, an infrabulge clasp is the clasp of choice for tooth no. 20, while circumferential clasps are chosen for tooth no. 28 and no. 31. The clasp of choice for tooth no. 20 using the RPI design is the I-bar.

6. Is additional indirect retention required beyond the direct retainers?

   The indirect retention should be positioned perpendicular to the fulcrum line. Remem-

**Figures 3.3.17a–d.** Views of the cast from the buccal aspect of tooth no. 28 and no. 31.



**Figures 3.3.18a and b.** Bilateral buccal views of soft- and hard-tissue contours represented on the cast.

ber, the fulcrum line is determined by a line drawn between the most posterior occlusal rests of the RPD (shown in black; Figure 3.3.19). The blue line perpendicular to the fulcrum line represents a possible location for indirect retention. In this case, the direct retainer on tooth no. 28 will also act as an indirect retainer. Based upon Kennedy Classification of Class II for the RPI philosophy, additional indirect retention is not recommended. This is a difference between the RPI design philosophy and the broad stress distribution philosophy, which would recommend additional indirect retention.

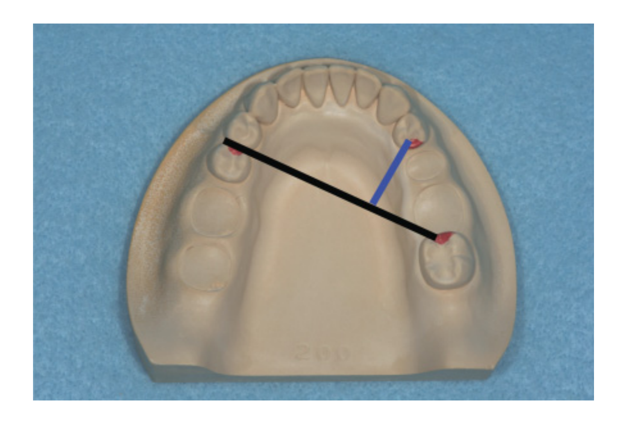


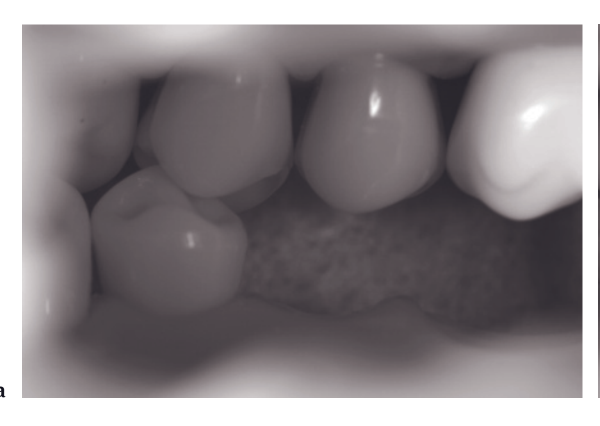
**Figure 3.3.19.** Occlusal view of mandibular cast. Black line drawn between the two distalmost rest seats representing the fulcrum line and the perpendicular blue line representing potential position of indirect retention needed.

7. What type of physical retention is best for the replacement teeth?

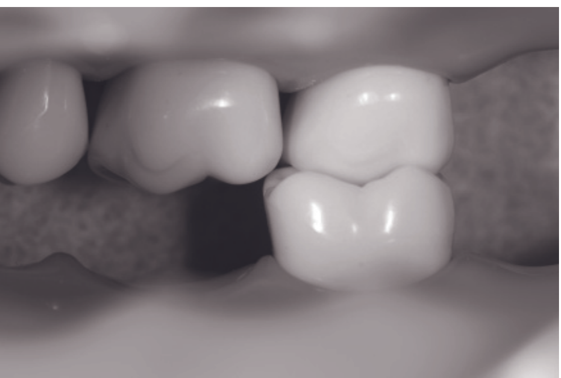
   Since latticework is considered the physical retention of choice for replacement of multiple teeth, the determination is made based on the inability to use this type of physical retention. If the lack of vertical space is not a limiting factor, then latticework should be selected (Figures 3.3.20a and b and Figure 3.3.21).
8. What major connector best connects the RPD components? (See Tables 3.1.4–3.1.6.)

   In the mandible, a minimum of 8 mm below the free gingival margin is required in order to use a lingual bar, the mandibular major connector of choice, as the major connector. Based on the clinical inspection as well as the cast, the available space is greater than the requirement (Figure 3.3.22).
9. What tooth modifications are required for this design?

   The tooth modifications needed based on this proposed design are mesial occlusal rest seats and distal guide planes on tooth no. 20 and no. 28, and a mesial occlusal rest seat and a mesial guide plane on tooth no. 31 (Figure 3.3.23 and Figures 3.3.24a and b).



a



b

**Figures 3.3.20.** View of interocclusal/interarch space. (a) Right side, premolar area. (b) Right side, molar area.




**Figure 3.3.21.** Physical retention—latticework—drawn on the preliminary cast.

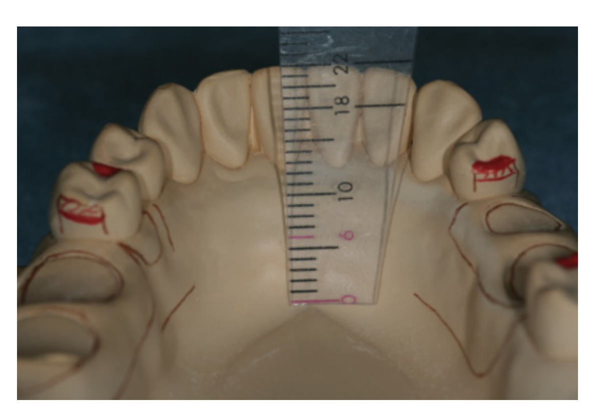


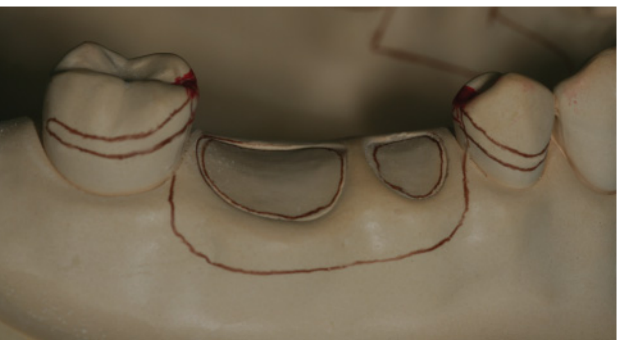

**Figure 3.3.22.** View of lingual aspect of mandibular anterior teeth (measuring available space from the free gingival margin to the depth of the lingual vestibule).




**Figure 3.3.23.** Photo of the proposed RPD design.

a





b

**Figures 3.3.24a and b.** Buccal views of clasps and clasp positions.

## 3.4 Kennedy Class III analysis and design

Using the patient in Figure 3.4.1, work through the process of designing a removable partial denture by answering the following questions.

## Kennedy Class III

1. Are there any limiting occlusal considerations?
2. Where are the edentulous modification spaces?
3. Where are the undercuts for the teeth adjacent to these areas?

   Viewing the cast from the buccal aspect, note the presence or absence of undercuts on the mesiobuccal, mid-buccal, and distobuccal surface of the prospective abutment teeth.
4. Where are the soft-tissue undercuts located?
5. Do the abutment teeth or the residual ridge require "protection" from external forces acting on the removable partial denture?
6. Is additional indirect retention required beyond the direct retainers?
7. What type of physical retention is best for the replacement teeth?
8. What major connector best connects the RPD components? (See Tables 3.1.4–3.1.6.)
9. What tooth modifications are required for this design?



**Figure 3.4.1.** Photo of patient.

1. Are there any limiting occlusal considerations?

   When designing a maxillary removable partial denture, the position of the occlusal contact becomes an important factor in rest seat placement (Figures 3.4.2a–c). Care must be taken to ensure that the rest seats and subsequent plating are positioned properly so that they do not impact on the occlusal vertical dimension (OVD). If the rest seat is placed incisal to the occlusal contact, the OVD may be inadvertently increased. There are no limiting occlusal considerations; rest seats may be placed on the cingulum of canines, and the mesial or distal occlusal of the premolar and molars. Either RPD design philosophy may be used. Therefore, other design considerations will determine which philosophy will be used, the broad stress distribution philosophy or the RPI design philosophy.
2. Where are the edentulous modification spaces?

   The white arrows in Figure 3.4.3 indicate the edentulous areas. Determine where the rest seats should be placed using Tables 3.1.1 and 3.1.2.

   The rest seats are drawn on the teeth adjacent to the edentulous areas. Note the position of the red rest seat drawn on the cast in Figures 3.4.4a and b.
3. Where are the undercuts for the teeth adjacent to these areas?

   Note the presence or absence of undercuts on the mesiobuccal, mid-buccal, and distobuccal surface of the prospective abutment teeth (Figures 3.4.5a and b).

   There appear to be undercuts on both the mesiobuccal and distobuccal of tooth no. 2 and no. 5. This will allow you to select either a circumferential clasp or a modified 1/2-T clasp. The determining factors of which type of clasp will be used are based on the presence of soft-tissue undercuts, the status of

**Figures 3.4.2a–c.** Photos of patient's occlusion.

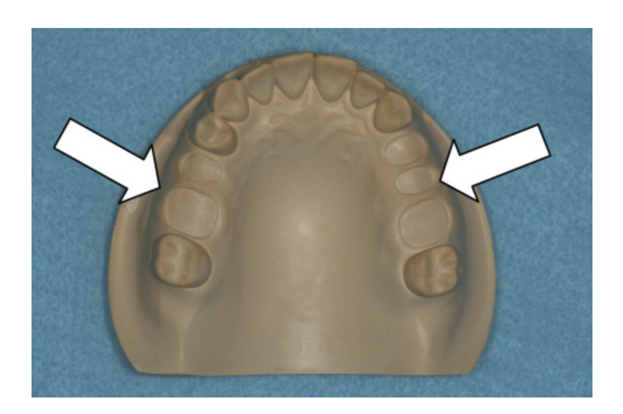


**Figure 3.4.3.** Photo of maxillary cast.

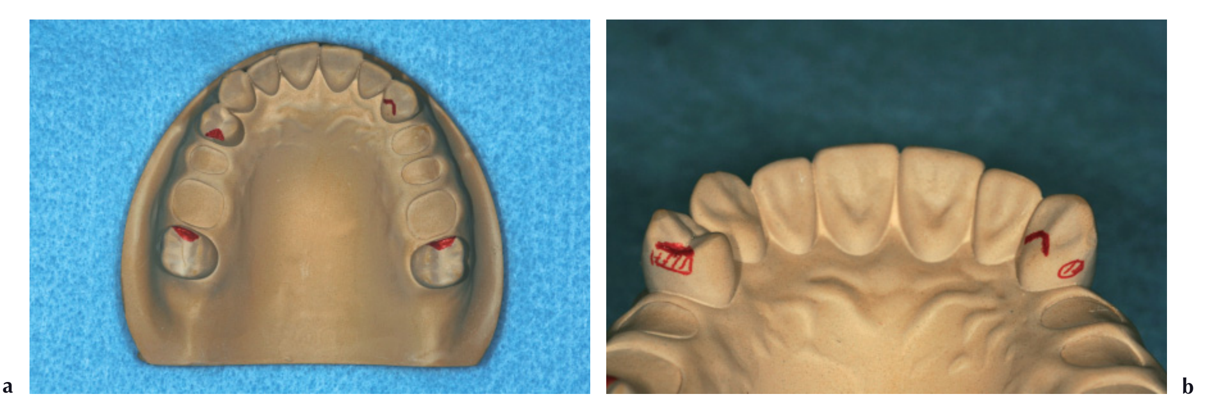
supporting structures (questions no. 4 and no. 5), and esthetic considerations.

Note the presence or absence of undercuts on the mesiobuccal, mid-buccal, and distobuccal surface of the prospective abutment teeth (Figures 3.4.6a and b).

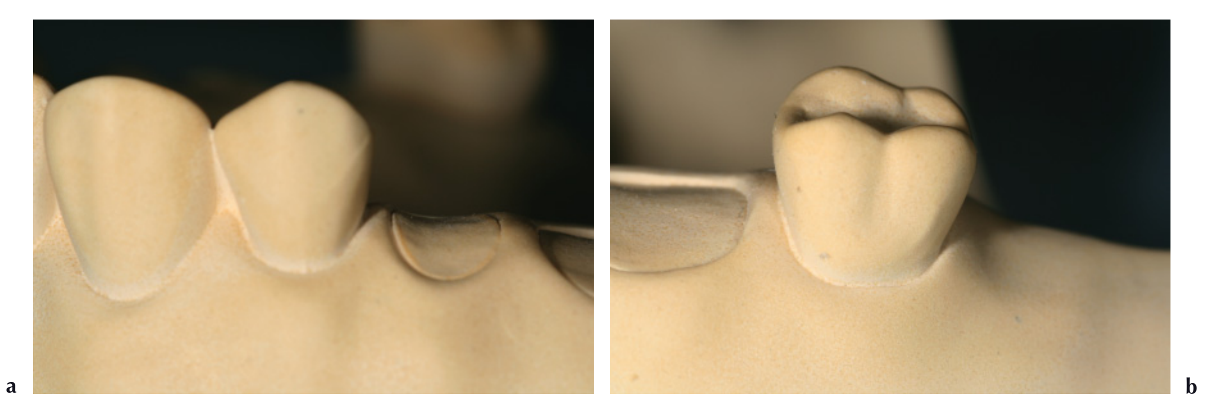
Tooth no. 11 and no. 15 appear to have both mesiobuccal and distobuccal undercuts. When clasping tooth no. 11, esthetics should be considered. A circumferential clasp into a mesiobuccal undercut would be visible unless the patient had a low smile line. An infrabulge clasp (I-bar or a modified 1/2-T clasp) would be a better choice for both esthetics and encirclement. When clasping tooth no. 15 simplicity is best since esthetics would not be a concern; in this instance, a circumferential clasp into the distobuccal would be ideal.

4. Where are the soft-tissue undercuts located?

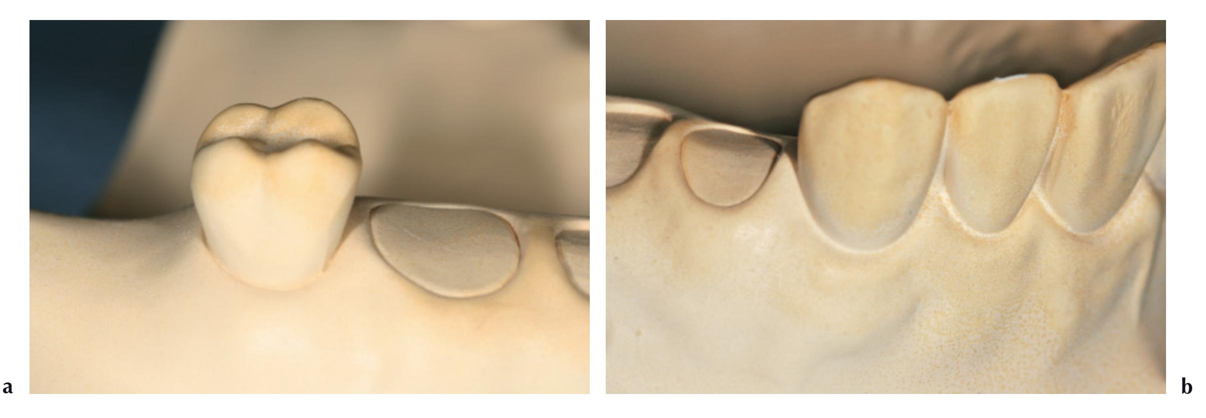
Note the position of the soft-tissue undercuts in order to determine if they will allow



**Figures 3.4.4.** (a) Photo of maxillary cast with rest seat drawn on the MO on no. 2, DO on no. 5, and cingulum on no. 11. (b) Proximal view of MO on no. 15; red hash marks represent needed guide planes.



**Figures 3.4.5a and b.** View of the cast from the buccal aspect of tooth no. 2 and no. 5.



**Figures 3.4.6a and b.** View of the cast from the buccal aspect of tooth no. 15 and no. 11.




**Figures 3.4.7a and b.** Buccal view of soft tissue on the cast.

for infrabulge or suprabulge clasps (Figures 3.4.7a and b). An infrabulge clasp is the clasp of choice when esthetics is an issue; however, there must be an adequate space above the soft-tissue undercut. In this example, there are no undercuts of significance around either anterior abutment tooth (no. 5 or no. 11). Therefore infrabulge clasps may be used in the removable partial denture design.

5. Do the abutment teeth or the residual ridge require "protection" from external forces acting on the removable partial denture?

   This information is obtained from the oral examination findings. Unlike a Kennedy Class I or II removable partial denture support, which is both tooth and soft-tissue supported, Kennedy Class III removable partial dentures are tooth supported. As a result their biomechanics are similar to a fixed partial denture in that they depend on a healthy periodontium for their entire support. Assuming for this patient that his or her periodontal status is healthy, an infrabulge clasp is the clasp of choice for tooth no. 5 and no. 11, while circumferential clasps are chosen for teeth nos. 2 and 15. The selection of a modified 1/2-T clasp into the distobuccal undercut of tooth no. 5 and no. 11 is a better choice in that the clasp will be hidden by the mesial half of the tooth.

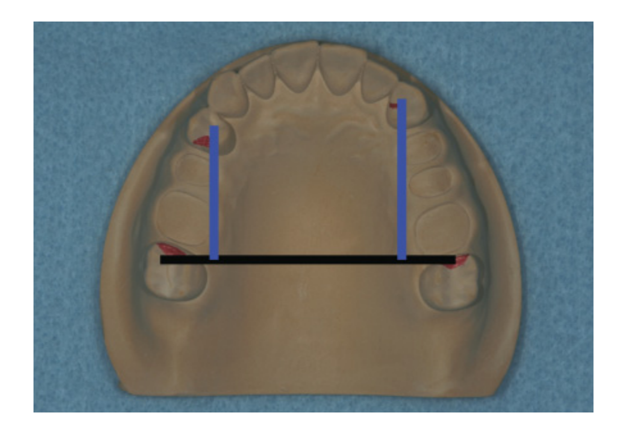
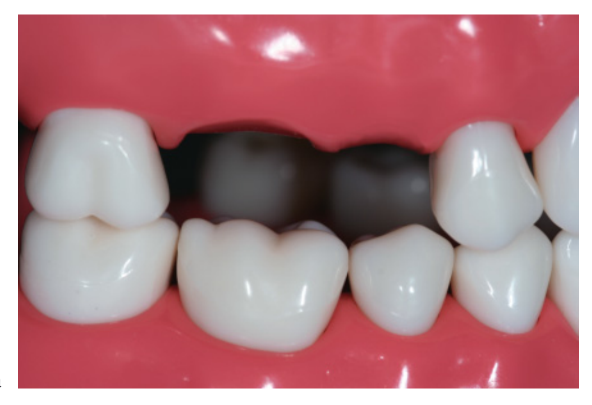


**Figure 3.4.8.** Occlusal view of maxillary cast: black line drawn representing the fulcrum line and the two blue lines perpendicular to the fulcrum line representing positions for indirect retention.

6. Is additional indirect retention required beyond the direct retainers?

   Indirect retention should be positioned perpendicular to the fulcrum line. Remember, the fulcrum line is determined by a line drawn between the most posterior occlusal rests of the RPD (shown in black; Figure 3.4.8). The blue lines perpendicular to the fulcrum line represent possible locations of indirect retention. Based upon Kennedy Classification of Class III, no additional indirect retention is





**Figures 3.4.9a and b.** View of interocclusal/interarch space. (a) Left side. (b) Right side.

needed due to the fact that the anterior direct retainers act as an indirect retainer.

7. What type of physical retention is best for the replacement teeth?

   Since latticework is considered the physical retention of choice for replacement of multiple teeth, the determination is made based on the inability to use this type of physical retention. If the lack of vertical space is not a limiting factor, then latticework should be selected (Figures 3.4.9a and b and Figure 3.4.10).

8. What major connector best connects the RPD components? (See Tables 3.1.4–3.1.6.)

   In the maxilla, the maxillary framework must be a minimum of 6 mm below the free gingival margin, and the minimum thickness of a palatal strap is 8 mm. In Kennedy Class III situations, anteroposterior palatal straps and palatal straps are commonly used. In this example, unless the length of the framework is going to be extended anteroposteriorly by plating the reciprocating arms, there is not enough space to use an anteroposterior palatal strap. Therefore, the maxillary major connector of choice for this patient would be a palatal strap.

9. What tooth modifications are required for this design?

   The tooth modifications needed based on this proposed design are mesial occlusal rest seats and mesial guide planes on tooth no. 2



**Figure 3.4.10.** Physical retention drawn on preliminary cast.

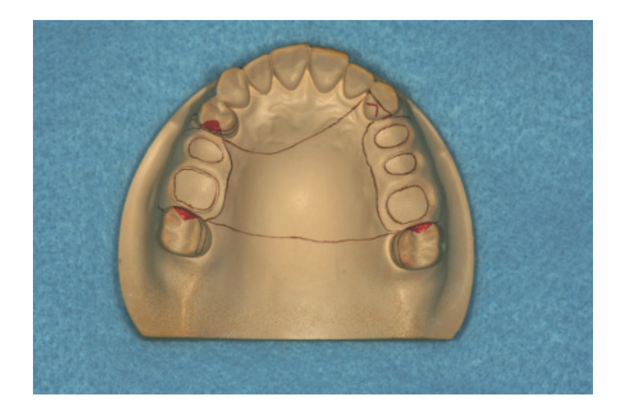
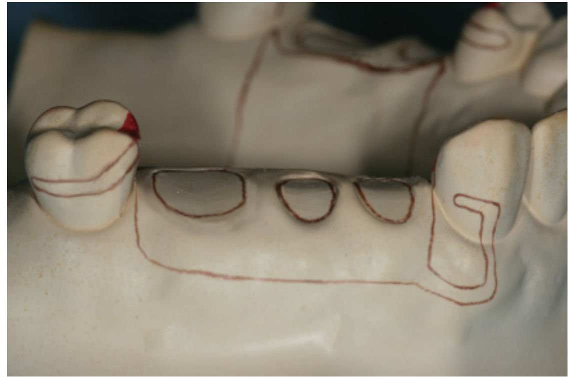


**Figure 3.4.11.** Photo of the proposed RPD design.





**Figures 3.4.12a and b.** View of clasps.

and no. 15, a distal occlusal rest seat and a distal guide plane on tooth no. 5, and a cingulum rest and distal guide plane on tooth no. 11 (Figure 3.4.11 and Figures 3.4.12a and b).

## 3.5 Kennedy Class IV analysis and design

Using the patient in Figure 3.5.1, work through the process of designing a removable partial denture by answering the following questions.



**Figure 3.5.1.** Photo of model-patient.

### Kennedy Class IV

1. Are there any limiting occlusal considerations?
2. Where are the edentulous modification spaces?
3. Where are the undercuts for the teeth adjacent to these areas?
4. Where are the soft-tissue undercuts located?
5. Do the abutment teeth or the residual ridge require "protection" from external forces acting on the removable partial denture?
6. Is additional indirect retention required beyond the direct retainers?
7. What type of physical retention is best for the replacement teeth?
8. What major connector best connects the RPD components? (See Table 3.1.6.)
9. What tooth modifications are required for this design?

1. Are there any limiting occlusal considerations?

   When designing a maxillary removable partial denture, the position of the occlusal contact becomes an important factor in rest seat placement. Care must be taken to ensure that the rest seats and subsequent plating are positioned properly so that they do not impact on the OVD. If the rest seat is placed incisally to the occlusal contact, the OVD may be inadvertently increased. In this clinical situa-







**Figure 3.5.2a and b.** Photo of patient's occlusion; lingual view of molars and premolars, respectively.

tion, there are no limiting occlusal considerations; rest seats may be placed on the mesial or distal occlusal of the premolar and molars (Figures 3.5.2a and b).

2. Where are the edentulous modification spaces?

   The white arrow in Figure 3.5.3 indicates the edentulous area. Determine where the rest seats should be placed using Tables 3.1.1 and 3.1.2.

   The rest seats are drawn on the teeth adjacent to the edentulous areas. Note the position of the red rest seat drawn on the cast in Figures 3.5.4a and b. There are two advantages to using the distocclusal of the most posterior molars (teeth nos. 2 and 15) for rest seat placement: it is more conservative of tooth structure than placing rest seats through embrasures and it is less likely to result in occlusal interferences.

3. Where are the undercuts for the teeth adjacent to these areas?

   Note the presence of undercuts on the mesiobuccal surface of the prospective abutment tooth no. 2 and no. 5 (Figures 3.5.5a and b).

   Note the presence of undercuts on the mesiobuccal surface of the prospective abutment tooth no. 13 and no. 15 (Figures 3.5.6a and b).

   A major design consideration to address in a Kennedy Class IV is the esthetics of this anterior region. Although either the broad stress distribution philosophy or the RPI design philosophy may be used to design an RPD, one should consider a *dual* or *rotational path RPD* design. In this scenario, using mesial undercuts of the anterior abutment teeth, tooth no. 5 and no. 13, for retention rather than the traditional clasps will provide a more esthetic result. Special instructions should follow to the dental laboratory technician to inform of the design for a rotational path RPD, as that will necessitate special attention to avoid blockout of the mesial surfaces and gingival areas on teeth nos. 5 and 13.

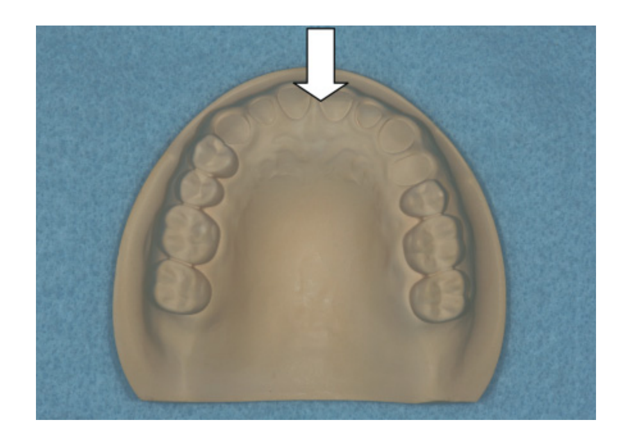
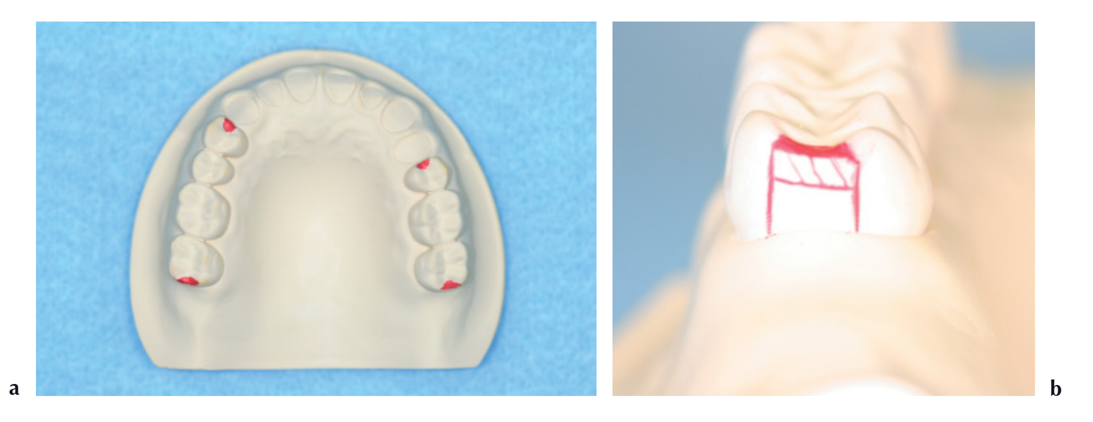
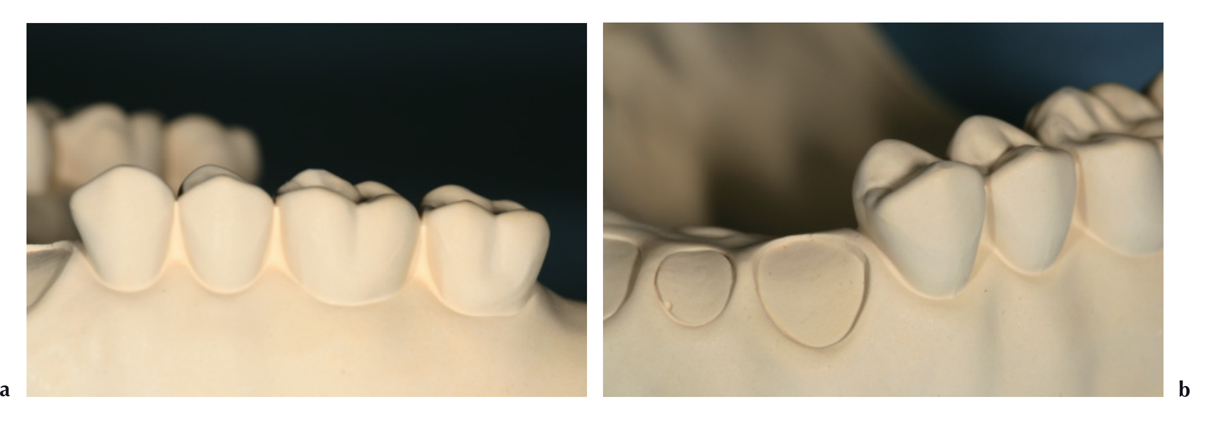


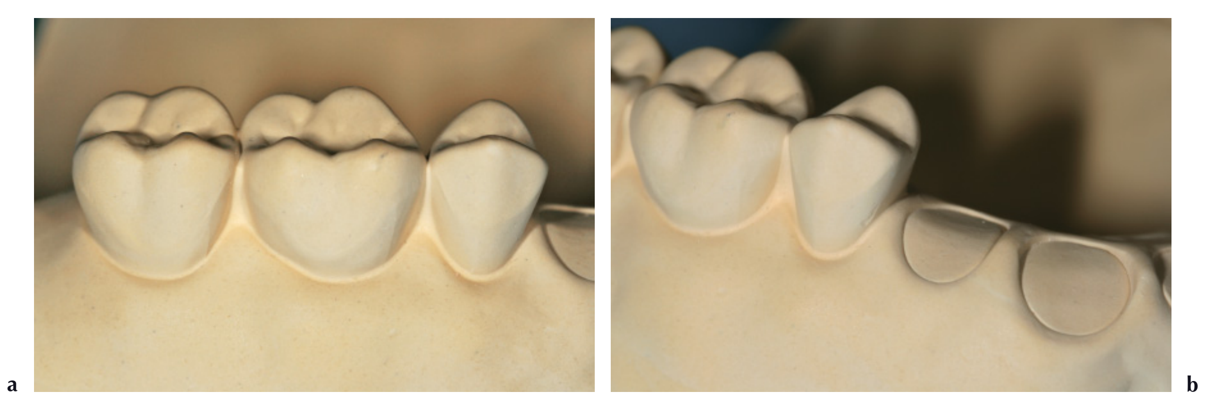
**Figure 3.5.3.** Photo of maxillary cast.



**Figures 3.5.4a and b.** (a) Photo of maxillary cast with rest seat drawn: MO on no. 4 and no. 13; DO on no. 2 and no. 15. (b) Proximal view of DO on no. 2; red hash marks represent needed guide plane.



**Figures 3.5.5a and b.** Viewing the cast from the buccal aspect of tooth no. 2 and no. 5.



**Figures 3.5.6a and b.** Viewing the cast from the buccal aspect of tooth no. 13 and no. 15.

Tooth no. 2 and no. 15 both appear to have mesiobuccal undercuts. A circumferential clasp into a mesiobuccal would provide the appropriate retention, be minimally visible, and require the least of amount of tooth modification.

Note absence of red hash marks representing needed guide planes (Figures 3.5.7a and b).

4. Where are the soft-tissue undercuts located?

Although this is always good information to know, the type of retention (clasp system) that has been tentatively identified for this patient scenario is suprabulge clasps and the position of soft-tissue undercuts would not have any impact on clasp placement or selection.

However, the soft tissue in the edentulous space should be evaluated for undercuts in order to determine issues related to type of physical retention and need for denture base flange.

Note there are no large soft-tissue undercuts to be of concern (Figures 3.5.8a and b).

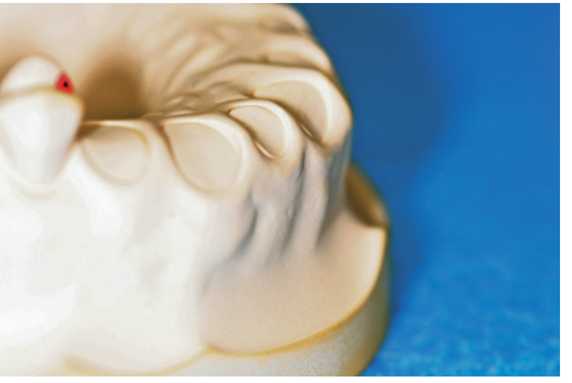
5. Do the abutment teeth or the residual ridge require "protection" from external forces acting on the removable partial denture?

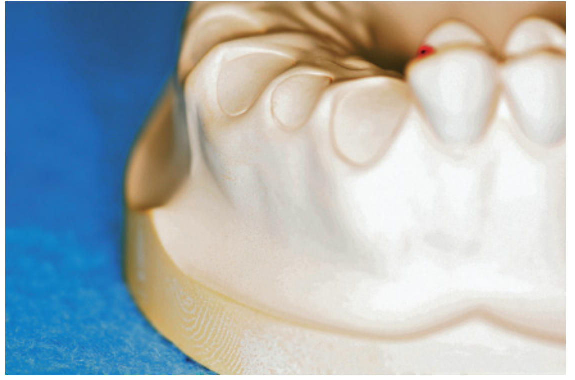
This information is obtained from the oral examination findings. Like the Kennedy Class III removable partial denture, the Kennedy IV removable partial denture is similar to a fixed partial denture and derives its support from the periodontium. However, biomechanically it is similarly to a Kennedy Class I in that the anterior segment may act similarly to a free-end edentulous space and requires additional direct retention that may act as indirect retention (Tables 3.1.1 and 3.1.2). Assuming for this patient that his or her periodontal status is healthy, the mesial proximal plates

a 

 b

**Figures 3.5.7a and b.** Photos of maxillary cast with rest seat and proximal plates drawn on the MO on tooth no. 4 and no. 13.

a 

 b

**Figures 3.5.8a and b.** Buccal view of anterior edentulous space.

will provide retention for the anterior abutment tooth no. 5 and no. 13, while circumferential clasps are chosen for teeth nos. 2 and 15.

6. Is additional indirect retention required beyond the direct retainers?

   Indirect retention should be positioned perpendicular to the fulcrum line. In the Kennedy Class IV, the fulcrum line is determined by a line drawn between the most occlusal rests surrounding the edentulous space of the RPD (shown in black; Figure 3.5.9). The blue lines perpendicular to the fulcrum line represent possible locations of indirect retention. Based upon Kennedy Classification of Class IV, no additional indirect retention is needed due to the fact that the posterior direct retainers act as an indirect retainer.

7. What type of physical retention is best for the replacement teeth?

   Since latticework is considered the physical retention of choice for replacement of multiple teeth, the determination is made based on the inability to use this type of physical retention. If the lack of vertical space is not a limiting factor, then latticework should be selected (Figure 3.5.10 and Figures 3.5.11a and b).

8. What major connector best connects the RPD components? (See Table 3.1.6.)

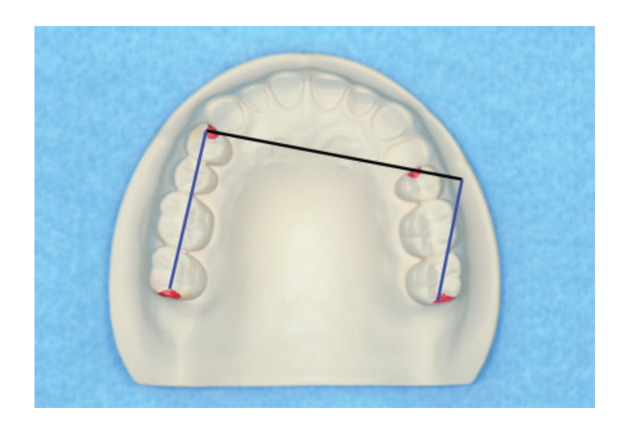
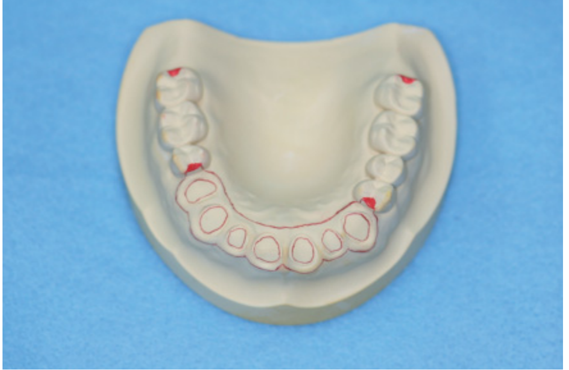


**Figure 3.5.9.** Occlusal view of maxillary cast: line drawn representing fulcrum line and perpendicular lines representing position of indirect retention.



**Figure 3.5.10.** View of interocclusal/interarch space.




**Figures 3.5.11a and b.** Physical retention drawn on preliminary cast.

In the maxilla, the maxillary framework must be a minimum of 6 mm below the free gingival margin, and the minimum thickness of a palatal strap is 8 mm. In Kennedy Class IV situations, the anteroposterior palatal strap (closed horseshoe) and U-shape are commonly used. The U-shape major connector in a Kennedy Class IV is more rigid than in some other configurations due to the major connector being on three vertical planes. In this example, both major connectors would be appropriate. Although not evaluated in the study referenced in Table 3.1.6, many patients prefer the U-shaped major connector. Additionally, it appears to be less bothersome to patients with gag reflex problems that have difficulty adapting to designs with palatal coverage (Figures 3.5.12a and b).

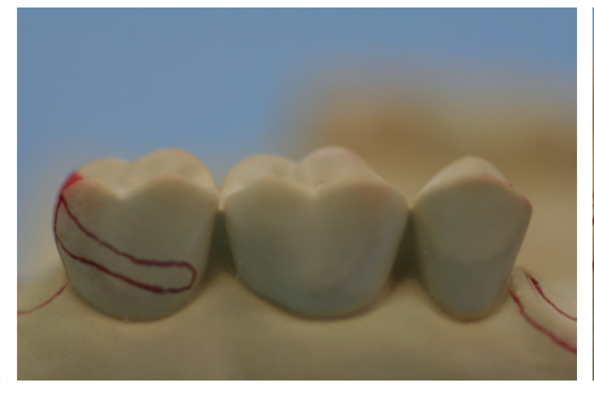
9. What tooth modifications are required for this design?

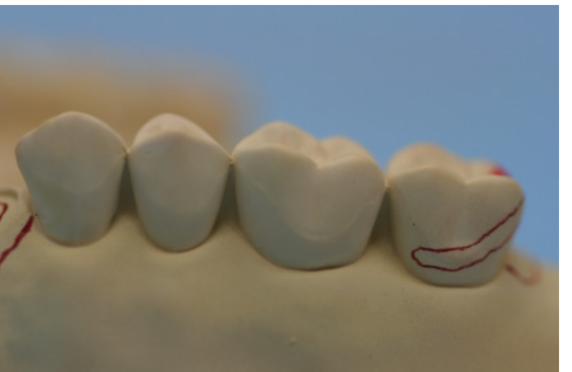
   The tooth modifications needed based on this proposed design are distal occlusal rest seats and distal guide planes on tooth no. 2 and no. 15, and a mesial occlusal rest seat and a mesial guide plane on tooth no. 5 and no. 13 (Figures 3.5.13a and b).


a


b

**Figures 3.5.12a and b.** Photos of the proposed RPD design. (a) Design using an anteroposterior strap major connector. (b) Design using a U-shaped major connector.


a


b

**Figures 3.5.13a and b.** Buccal view of clasp positions.

# 4 Clinical Care of the Patient

## 4.1 Preparation of the mouth to receive an RPD

Evaluation of a patient's existing intraoral conditions is an essential part of treatment planning for a removable partial denture prosthesis. The oral cavity should be evaluated as a whole and not limited to the presence or absence of teeth. The anatomic form of the remaining teeth, surrounding anatomical structures, and quality of mucosal tissues should be assessed in order to determine ability to support a prosthesis. The patient needs may be divided into the primary disciplines of dentistry: surgery, periodontics, endodontics, prosthodontics, and orthodontics.

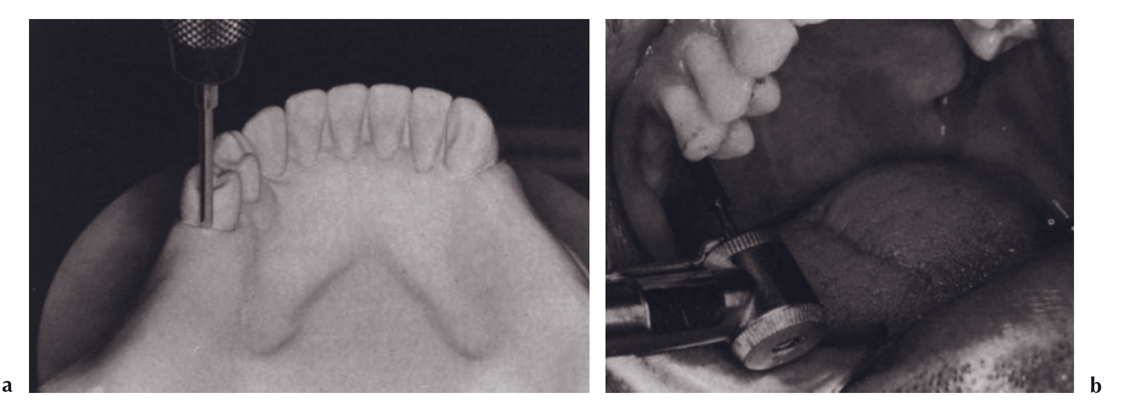
Surgically, the teeth, bone, and soft tissues should be evaluated to determine the need for surgical intervention. Surgical considerations include (1) structurally compromised teeth that may require extraction, (2) malpositioned or supraerupted teeth that may require extraction, (3) enlarged tuberosities that may require soft- or hard-tissue reduction, (4) exotoses and tori that may require removal or alveoloplasty, and (5) displaceable tissue, hyperplastic tissue, or an epulus that may require excision.

The periodontal status of the patient should be evaluated with regard to periodontal disease and plaque control. Periodontal disease control should be initiated when appropriate prior to the initiation of the definitive prosthodontic treatment.

As part of the evaluation process of the remaining teeth, a decision should be made with regard to the appropriateness of salvaging teeth through the use of endodontics. For example, an extruded or supraerupted tooth may be saved from extraction through endodontic therapy, reduction of the occlusal surface to realign the tooth into the proper plane of occlusion, and a crown.

Evaluate the mouth from a prosthodontic perspective, including caries detection and identifying defective restorations, structurally compromised teeth, occlusal plane discrepancies, malocclusion, and need for modification. Occasionally teeth may need to have crowns placed to correct these problems. In addition, during the surveying process of treatment planning for removable partial denture design, teeth should be evaluated for acceptable crown contours, and the need for enameloplasty to correct tooth contours, create rest seats, and develop guide planes.

Once an appropriate removable partial denture design has been determined, tooth modifications may be undertaken. Tooth modification may be both subtractive as well as additive. Figures 4.1.1 through 4.1.4 illustrate typical examples of tooth modifications. In addition to the tooth modification discussed above, surveyed crowns



**Figures 4.1.1a and b.** The guide plane is parallel to the path of insertion, shown here using a surveyor with analyzing rod to demonstrate the path of insertion/removal (a). The guide plane is created using parallel sided burs, intraorally (b).

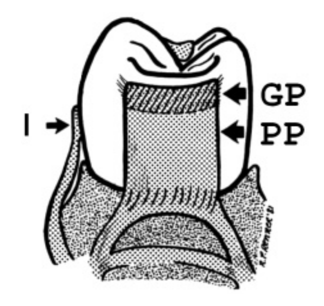



**Figure 4.1.2.** The length of the guide plane varies according to design philosophy; however, the guide plane is prepared on the interproximal surface, line angle to line angle from a buccolingual perspective. The guide plane (GP) is on the tooth surface, the proximal plate (PP) is the metal component of the RPD framework, and an I-bar (I) is shown on the buccal surface of this diagram.

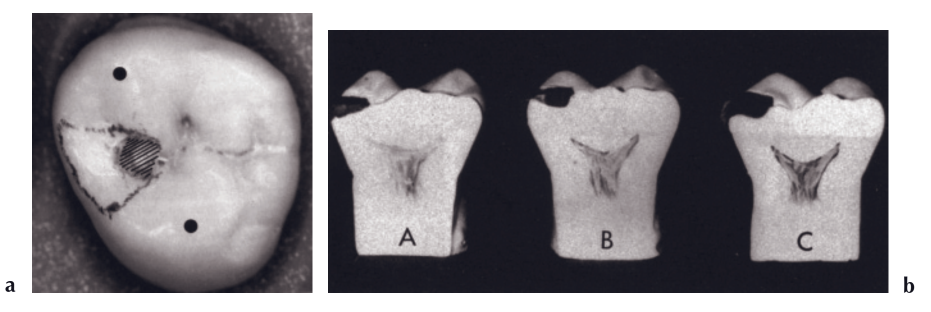
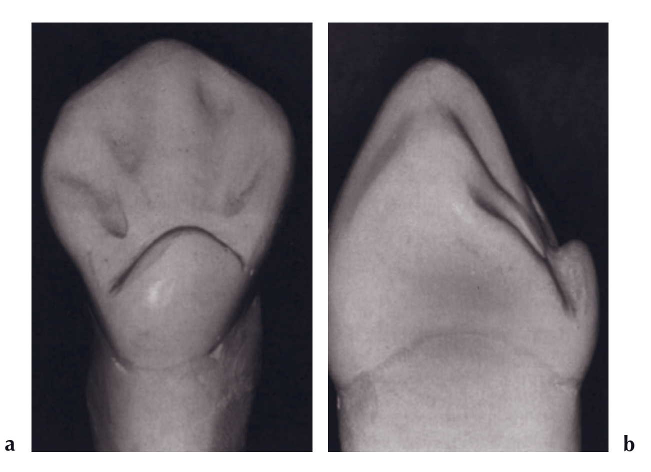



**Figure 4.1.3.** a. Occlusal rest seat area is shown from an occlusal view. The typical occlusal rest is a spoon-shaped, rounded triangle. It should be 1.5 mm thick occlusogingivally, at the junction of the rest seat and minor connector. It is one-third the width of the tooth buccolingually. b. Three examples of occlusal rest seat preparation in cross-section. (A) and (B) illustrate poor rest seat preparations that do not provide a positive seat for a metal rest. (B) demonstrates inadequate marginal ridge reduction, leaving a sharp edge on the ridge. (C) shows an acceptable form for an occlusal rest seat.



**Figures 4.1.4a and b.** The cingulum rest seat preparation requires a prominent cingulum. The preparation is a chevron or inverted "V"-shape mesiodistally (a), and a concave "V"-shape buccolingually (b). The internal line angles should be rounded. When an anterior tooth does not have a cingulum that is prominently sufficient to prepare without exposing the dentin, composite resin may be used to develop the prominence needed; the cingulum rest should be created such that at least half of the rest seat is in enamel. The careful use of composite resin on a cingulum, either mandibular or maxillary canine, is preferable to preparing an incisal rest seat since use of an incisal rest seat creates an unacceptable esthetic result.

may be fabricated from gold and metal ceramic materials that have the desired modifications incorporated in them.

## 4.2 The master impression

Making the master impression for fabrication of a removable partial denture (RPD) prosthesis is accomplished once the remaining teeth in the partially edentulous arch have been modified. The modifications, including intracoronal and extracoronal restorations and/or enameloplasty to enhance extracoronal contours, should follow the treatment plan derived after careful analysis, design, and prescription for the prosthesis.

### Selection of impression material

It is important to make an accurate impression in order to ensure the accuracy of the resulting master cast. The elastomeric impression materials available for use for the final impression include a range of materials from irreversible hydrocolloid (alginate) to vinylpolysiloxane or polyether impression materials. The range of choices varies according to the preference of the clinician. Historically, use of irreversible hydro-

**Procedures**

- It is important to make an accurate impression in order to ensure the accuracy of the resulting master cast.
- The elastomeric impression materials available for use for the final impression include a range of materials from irreversible hydrocolloid (alginate) to vinylpolysiloxane or polyether impression materials.
- The ultimate goal is to obtain an accurate cast for fabrication of a removable partial denture prosthesis.

colloid material—alginate—has been advocated based on multiple factors such as: the material is used widely in most dental practices, there is ease of handling and manipulation by support personnel, and it is relatively inexpensive and does not require special equipment in the office, in most instances. The key disadvantage in use of this material relates to the handling characteristics, in that there is a relatively short time period in which the material is accurate. The short period of time for predictable accuracy of alginate is based on the physical properties such as syneresis; the loss of fluid occurs in a short period of time and can affect the accuracy of the master cast. If managed properly, alginate impression material is cost-effective when pouring the master cast can be accomplished immediately after the impression is removed and disinfected. This implies the master cast is poured in the office in a timely fashion—less than 12–14 minutes from removal—rather than shipping the impression to an off-site dental laboratory for fabrication of the master cast at a later time. If the latter is preferred, the vinylpolysiloxane or polyether impression materials may be the impression material of choice since under the right conditions, either maintains accuracy for a longer period of time when compared to alginate impression material. The ultimate goal is to obtain an accurate cast for fabrication of a removable partial denture prosthesis.

## Tray selection

While the impression material of choice may be influenced by the nature of a dental practice, it is most important to consider the intended goals of the impression procedure. This is where clinical judgment in each step of the clinical procedures is based on the patient's clinical presentation. In addition to trying to capture intricate details of the tooth surfaces, the residual alveolar ridge anatomy is important in providing soft-tissue support with an increase in numbers of missing natural teeth. The condition of the residual ridge influences the amount of support that is possible in Kennedy Classifications I, II, and IV since the RPD designs require a philosophy of both tooth and tissue support for the removable prosthesis.

The choice of an impression tray can include stock impression trays both made of metal or the more rigid plastics available. The use of rigid plastic impression trays can be advantageous since most are intended to be disposable and do not require additional dental assistant time for cleaning after use. Stock impression trays are available as rim-lock or other mechanical retention design such as perforated trays, and both can be modified for use intraorally to meet the anatomical features of the patient. The prime consideration in tray selection is to choose one with the absolute rigidity that must be afforded by the tray material. If one were to choose use of a metal stock tray filled with a rigid impression material such as a polyether, this might prove to be difficult to recover in a patient with severe tissue undercuts. Also, if the metal tray can be removed clinically with minimal discomfort, the distribution of missing teeth could make recovery of an intact master cast difficult. For example, if a patient presents with a partially edentulous tooth loss pattern of "every other tooth" missing, retrieving a master cast from a stiff impression material may result in multiple broken teeth that cannot be repaired on the master cast.

The next decision to be made is selection of the proper size and shape of the tray to take advantage of the dimensional accuracy of the impression material and to include all necessary anatomic landmarks in the impression. An impression tray of the correct size and form for an irreversible hydrocolloid impression material is one that will permit its easy insertion and removal from the mouth with a clearance of one-quarter inch in all regions. For a vinylpolysiloxane or a polyether impression material, the thickness is described as having a minimum of approximately 2 mm thickness at the closest proximity to a soft-/hard-tissue surface.

In either instance, a tray adhesive should be used routinely to ensure the impression material adheres to the tray surface, in addition to the

advantage of mechanical retention design that might be incorporated into the stock tray. With an improved selection of various tray sizes, some tray modification to accommodate extensive tissue loss, specifically related to the area of edentulous spaces, may or may not be necessary. When using alginate as the impression material, excess thickness of alginate increases the probability of distortion of the material around teeth adjacent to edentulous areas, and/or that the material itself is not dimensionally stable in those same areas. It is for these reasons that a stock tray may require modification to ensure accuracy (Figures 4.2.1 through 4.2.5).



**Figure 4.2.1.** A metal, non-perforated stock tray has been modified with impression compound to support the alginate impression material in the palate. Without modification, the alginate may "slump," which could affect the fit of an RPD major connector onto the palatal surface. Note the varying thickness of the impression material when viewed in cross-section as compared with Figure 4.2.2. Also note typical porosity of alginate when the impression material is hand spatulated for a final impression, in addition to the separation of material along the buccal vestibule.



**Figure 4.2.3.** After a framework is made, the opportunity to evaluate the fit of the framework reveals the mandibular major connector—the lingual plating—does not fit well on the mandibular anterior teeth, nor is the rest seat seated into the preparation on the mandibular left posterior tooth, tooth no. 21. This implies the final impression was distorted, which in turn resulted in a mandibular master cast that was distorted.



**Figure 4.2.2.** Within the same impression procedure, as shown in Figure 4.2.1, varying thickness of the impression material occurs, but in most instances is evaluated solely by viewing the intaglio surface after removing the impression.

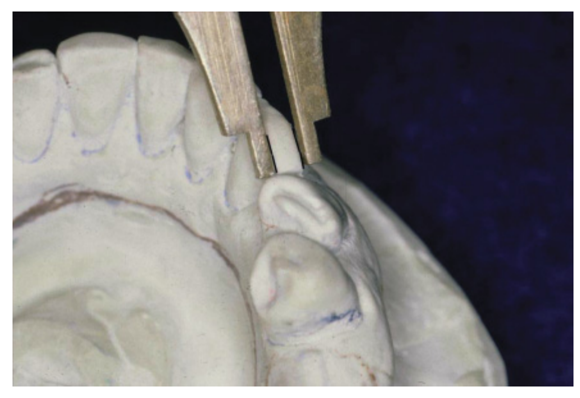


**Figure 4.2.4.** Close inspection of a new master cast was made to compare the width of the distoincisal edge, which was deemed accurate when compared to the natural tooth.



**Figure 4.2.5.** The measurement made of the natural tooth was coincident with the width of the same tooth on the master cast (Figure 4.2.4). In this figure, the same measurement was compared with the master cast made from a distorted impression. There was a measurable discrepancy that could be interpreted as the alginate impression material separated from the impression tray so the incisal edge appears more narrow than the natural tooth. This error on a master cast leads to fabrication of an RPD framework that does not fit intraorally and requires a new impression procedure and remake of the RPD framework. This is a difficult error to detect clinically, and use of a perforated tray in addition to use of a compatible impression material adhesive helps reduce this error.

Traditional use of impression modeling plastic (impression compound) has been taught but requires additional equipment for use. Waxes have been used but are not dimensionally stable, nor can a wax adhere to an impression material (Figures 4.2.6 through 4.2.9). Alternatives to adding a material for tray modification prior to making the final impression include adding a corrected cast (altered cast) impression or the use of a postinsertion reline of the denture base extension for improved tissue-bearing (intaglio) surface extension and replication.



**Figure 4.2.6.** The use of a disposable, rigid plastic impression tray is acceptable for a final impression procedure. In this instance, a heavy-bodied vinylpolysiloxane material is used in the tray with a thin separating sheet for creating an initial customized tray for the subsequent "wash" impression. The separating sheet is removed prior to the "wash" impression with a light-bodied vinylpolysiloxane impression material. Use of this procedure is convenient for use with the automix dispenser systems available for most vinylpolysiloxane impression materials.



**Figure 4.2.7.** The initial impression of this two-stage impression procedure has been accomplished; the thin separating sheet has been removed and excess material has been trimmed. The folds created with the separating sheet serve as sluiceways for excess wash material to flow once the tray is seated intraorally.

## Elimination of corrected cast

The use of the corrected cast procedure occurs after a separate framework try-in to verify fit of the RPD framework, as verified for fit on remaining natural teeth. The intent of this procedure is based on the clinician's ability to record soft-tissue support functionally. This can be accomplished without the use of the corrected cast procedure by incorporating a careful evaluation of the completed prosthesis clinically at the insertion appointment. After fitting the prosthesis, if there appears to be insufficient border extension or insufficient tissue contact on the



**Figure 4.2.8.** The initial impression is evaluated; it creates a customized impression tray related to fit around teeth and the edentulous areas. The edentulous areas have been filled in a vertical dimension, but the vestibular areas may not be extended completely.

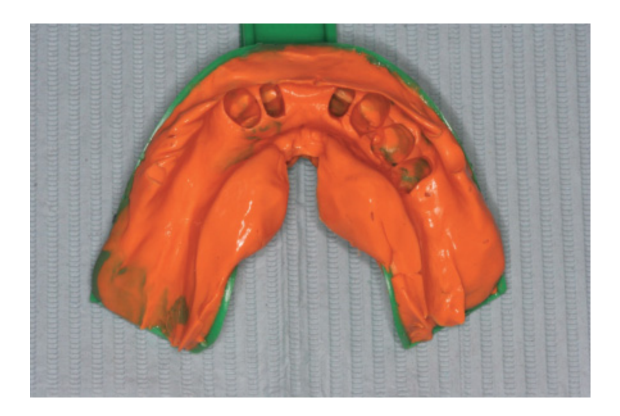


**Figure 4.2.9.** The wash impression has been accomplished and the impression should be inspected. Note the sublingual areas have been captured well. The bilateral, distalmost extensions, posterior retromolar areas, are deemed insufficient in support of a broad distribution of forces philosophy. The impression is accepted for fabrication of the RPD framework, but the final RPD will be relined to capture maximum coverage of supporting soft tissues.

intaglio surface, a chairside reline or a laboratory reline can be accomplished with a functional reline procedure.

## Clinical judgment

Clinical judgment begins immediately when using any impression material at the mixing stage. Most impression materials, excluding reversible or irreversible hydrocolloids, are dispensed using an automix system, either from a bulk mechanical dispenser or through a cartridge system. When using a vinylpolysiloxane or polyether impression material, the clinician must make the judgment on tray selection carefully since partially edentulous patients may well have exaggerated soft-tissue undercuts that make impressioning with a stock metal tray hazardous, in that retrieval can be very difficult. The use of a rigid plastic stock tray may be preferred since the minimal flexibility that exists with a stiff plastic impression tray may be sufficient to allow for easier tray removal, rather than creating an uncomfortable situation for a patient.

As with any impression material, it is difficult to discern whether or not the impression is distorted upon removal from the mouth. The clinician can take certain precautions to minimize the possibility by using a perforated tray and tray adhesive, and by following procedures that fall within the limits of handling characteristics. The latter poses a key disadvantage with alginate impression material. In order to meet clinical infection control standards, the impression should be disinfected following time guidelines prescribed using a particular product, and then poured. The additional time required to meet the infection control guidelines compromises the limits of accuracy since most manufacturers require the impression to be poured within 14–16 minutes. When the dental assisting staff can be trained to be efficient in handling an alginate material, both in mixing and in managing disinfection prior to pouring the impression, a final impression made using an alginate material can provide a high level of accuracy in fabricating a removable partial denture framework. In the simplest terms, the impression of a partially edentulous patient creates a full-arch “die” from which the dental laboratory technician must fabricate a framework. Based on the level of accuracy most clinicians expect for quality of a fixed prosthesis such as a single-unit crown or a fixed partial denture, the highest expectations should exist for removable prosthodontics.

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## 4.3 Fitting the framework

### The fit of the framework

Why should a clinician be concerned with the fit of the framework? The rationale for having the clinician take responsibility for the fit of the framework is the same as the clinician taking responsibility for ensuring a single crown fits to the highest clinical standards suggested through the literature, so as to provide the patient with the highest quality of care over the long term.

#### *Initial inspection*

When the removable partial denture framework is returned from the dental laboratory, the metal casting should be carefully inspected both off and on the master cast (Table 4.3.1). Use of magnification such as dental loupes or a microscope is recommended. The surface of the frame-

**Table 4.3.1.** Framework evaluation.

| Framework evaluation |
|---|
| Initial Inspection |
| ■ The surface of the framework should be smooth and free from scratches and other defects. |
| ■ Careful inspection should be made to ensure that the framework follows the design submitted to the laboratory exactly. |
| Laboratory Inspection |
| ■ The metal framework should next be inspected while seating the framework on the master cast. |
| ■ The framework should sit passively on the master cast without wedging or impinging on the abutment teeth. |
| ■ Adjustments are accomplished as needed until the metal casting is completely seated. |
| Clinical Procedures |
| ■ The framework should be inspected using both vision and tactile sense while seating onto the abutment teeth. |
| ■ The casting should fit passively without rocking or teetering. |
| Occlusal Evaluation |
| ■ The framework should then be evaluated for clearance during patient articulation. |
| ■ The framework should be adjusted as needed until there is no contact of the metal against opposing teeth, prostheses, soft tissues, or metal frameworks. The adjusted areas should be repolished as needed. Following these adjustments, the patient should report occlusal stability and comfort. |

work should be smooth and free from scratches and other defects (Figure 4.3.1). Careful inspection should be made to ensure that the framework follows exactly the design submitted to the laboratory (Figures 4.3.2a and b). Ensure that all rest seats, indirect retainers, retention clasps, reciprocating clasps, major and minor connectors, and other components are present and well constructed as requested on the design cast (Figure 4.3.3). Metal framework components and connectors should be measured with calipers to ensure a minimum of 1.5 mm base metal alloy thickness for strength. Obvious defects in craftsmanship will compromise the fit and strength of the casting and therefore require remake at a cost to either the laboratory, or the dentist (Table 4.3.2).



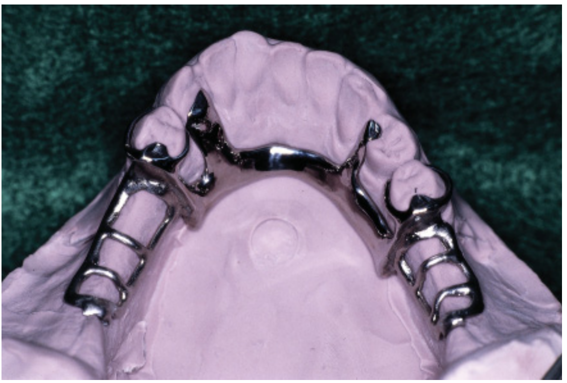
**Figure 4.3.1.** Following return from the dental laboratory, the metal framework should be smooth and free from scratches and pits.

The intaglio surface of the framework should also be inspected using magnification. Casting imperfections such as voids and nodules should be identified and removed or smoothed as indicated. There should be no voids or porosities present in high-stress areas such as where clasps and rest seats are connected to minor connectors. Internal and external finish lines should be sharp, well delineated, and less than 90° to provide adequate mechanical retention of the resin denture base to the metal framework. When returned from the laboratory, all external metal components should be highly polished with the exception of the intaglio surface of the maxillary major connector, in an effort to provide close adaptation to the palatal tissue. The internal components of the metal framework that contact tissue should have a smooth, matte-finished surface that maintains intimate soft-tissue contact.

The RPD framework should also be examined while seated on the master cast. Close scrutiny should be given to the adaptation of the major connector as well as the rest seats and clasps to the master cast. A metal frame that does not fit the master cast well will not likely fit the patient's mouth. If discrepancies are observed, the

a





b

**Figures 4.3.2a and b.** The metal framework should be carefully compared to the submitted design cast to ensure that all components of the removable partial denture were incorporated according to the prescription.



**Figure 4.3.3.** Careful inspection of the framework should be accomplished using magnification.

**Table 4.3.2.** Framework try-in—additional procedures.

Clinical Procedures After Fitting the Framework

- The cast is corrected or altered.
- This impression procedure is often required when the removable partial denture involves long-span distal extensions or long-span anterior edentulous areas.
- The acrylic resin trays adapted on the framework can now be border molded in the mouth using green stick compound. After placing the appropriate adhesive, a thin viscosity polyvinylsiloxane material can be used for the final impression. In the laboratory, procedures can be accomplished to make a more accurately altered cast.

Maxillomandibular Records

- These records can be made at the same appointment as when fitting the framework.
- A facebow transfer records the position of the maxilla on three planes in relation to the temporomandibular joint.
- Interocclusal records: If the patient casts cannot be accurately hand articulated, interocclusal records must be made.

Tooth Selection

- Following the framework try-in, selection of color and size of acrylic resin denture teeth can also be made.

framework should be refined as needed. This step in evaluation of the framework is critical, comparable to when one inspects the accuracy of fit of a single-unit casting on a master die in fixed prosthodontics.

## Methods and procedures for fitting the framework

### *Laboratory inspection*

The initial fitting of the framework should first occur in the dental laboratory well before the patient arrives for the clinical appointment. As mentioned above, the framework should be analyzed off and on the master cast using magnification. Initially, the internal surface of the framework should be examined for obvious casting nodules, polishing paste, or other debris, which should subsequently be removed with a #2, #4, or #6 straight-shank round bur. Size of the round bur used will depend on the size of nodule or debris and the available space to maneuver within the framework confines.

The metal framework should be inspected next while seating the framework on the master cast. If heavy rubbing against the cast or excessive seating pressure is required, the framework should be relieved to achieve smooth insertion onto the master cast. The framework should also be analyzed while seated on the master cast. Close observation should be given to the full seating and adaptation of the major connector, clasps, rest seats, and indirect retainers. The framework should sit passively on the master cast without wedging or impinging on the abutment teeth. If not fully seated, the internal surface of the framework should be painted with a disclosing medium such as chloroform and rouge paste, or disclosing wax (available in commercial dental laboratory settings), calcium carbonate spray such as Quick Check Indicator Spray (Vacalon, Pickerington, OH) or silicone-based disclosing media such as Fit-Checker (GC America Inc., Alsip, IL). The framework should then be seated on the master cast using firm pressure. After removing the framework from the cast, it should be inspected under magnification for indication of internal high spots or frictional discrepancies as detailed by the disclosing medium. Adjustments are accomplished as needed until the metal casting is completely seated. Following adjustments, the metal frame-

work should be cleaned with steam and then placed in an ultrasonic cleaning solution.

### Clinical procedures

Once the framework is fitted to the master cast, the casting is ready for clinical try-in. When the clinician receives the framework from the dental laboratory, this is an opportunity to inspect the fit to the master cast. Although requests to have the removable partial denture be fabricated to completion without an additional appointment to fit the framework may be common, each patient should receive consideration based on his or her diagnosis and intraoral assessment. For instance, fabrication of a removable partial denture in a patient Kennedy Class I with an extensive number of missing posterior teeth associated with moderate to extensive residual ridge bone loss may indicate the necessity for a separate appointment to fit the framework and need for additional clinical procedures. If the impression technique utilized is predictable and accurate, and the dental laboratory technician and the dental laboratory provide high-quality, well-made frameworks on a consistent basis, it is the judgment of the clinician whether or not to proceed to final fabrication of the completed removable partial denture. The clarity afforded the clinician is when the framework has been fitted as one would for a fixed unit casting to ensure the best possible fit. If the RPD is completed without verifying the fit of the framework, the risk is the difficulty in discerning a fit problem if adjustments are required for both the acrylic resin portion on the intaglio surface and the framework.

The framework should be inspected using both visual and tactile sense during seating onto the abutment teeth. Direct seating pressure should be applied to the rest seats and major connector only, as pressure applied to tissue-borne denture base areas will cause the denture to pivot and rock. Excessive force to seat the framework should not be required. The casting should go into place in a smooth manner without binding or catching the abutment teeth. Once seated, the framework should be inspected for complete stability. The casting should fit passively without rocking or teetering. All major and minor connectors should be checked with magnification for close adaptation to the teeth and tissues. In addition to the disclosing mediums previously mentioned, disclosing wax can be used to ensure there are no interferences causing binding or incomplete seating of the casting (Figure 4.3.4). Common areas to inspect are along guide planes, under rest seats, in the shoulder areas of clasps, and on minor connectors (Figure 4.3.5). Adjustment should continue

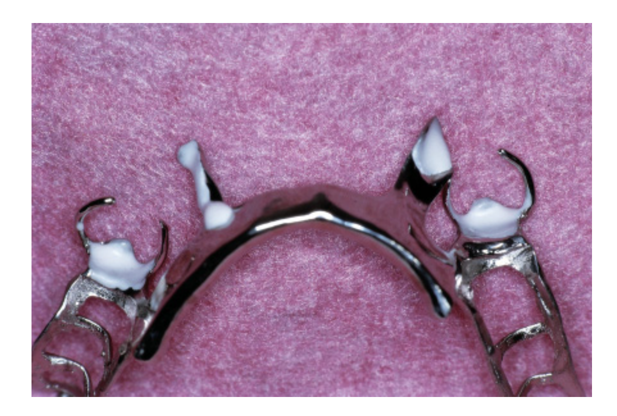


**Figure 4.3.4.** Using a heated spatula, a thin coat of disclosing wax is spread onto the internal framework components.



**Figure 4.3.5.** A slurry paste mixture of chloroform and rouge can be used as a disclosing medium. Areas commonly adjusted include under clasp arms and rest seats, and along minor connectors adjacent to guide planes.

to be made with high-speed diamond burs, carbide burs, or abrasive stones until the casting is fully seated. If the casting still will not go into place after several attempts at fitting the framework, a decision should be made to remake the framework. A framework that fits the master cast but not the mouth indicates that the master cast is inaccurate and a new impression should be made to initiate the remake of the framework.

### *Occlusal evaluation*

The framework should then be evaluated for clearance during patient articulation. Initially, remove the framework from the patient's mouth and ask him or her to occlude. Analyze the bite closely, and observe whether opposing cusps fit into wear facets or if opposing canines fully articulate together. With this picture in mind, try in the metal framework and look for the same articulation. If open spaces are observed, the framework is elevated in occlusion and must be adjusted. When both maxillary and mandibular frameworks are being tried, they should be done individually before they are done together. Common areas of occlusal interferences are on rest seats, clasp shoulders, and minor connectors. Thin articulating marking paper such as Accufilm (Parkell, Edgewood, NY) or disclosing wax can be used to discern high spots on the metal frame. Often it is difficult to mark and visualize highly polished areas, so a matte finish with micro-abrasion may be desired in these occluding areas. Disclosing wax can also be easily visualized when used to check occlusion (Figure 4.3.6).

Metal calipers should be used routinely after adjustments to ensure at least 1.5 mm thickness of metal remains along rest seats, clasps, and minor connectors. Metal less than 1.5 mm in thickness will likely fracture or deform under function and necessitate remake. Rather than thinning the metal too aggressively, in some instances it may be necessary to reduce the opposing dentition.

The framework should be adjusted as needed until there is no contact of the metal against opposing teeth, prostheses, soft tissues, or metal frameworks. The adjusted areas should be repolished as needed. Following these adjustments, the patient should report occlusal stability and comfort. Further clinical procedures should be continued only after these criteria are strictly met.

a





b

**Figure 4.3.6.** (a) Disclosing wax is heated and spread along areas occluding against opposing dentition. (b) High spots are easily observed where disclosing wax has been displaced. This material is especially useful on highly polished alloys where disclosing materials such as articulating film are not readily observed.

## Clinical procedures after fitting the framework

Once the metal framework has been adjusted and fitted, there are several options available at this same appointment to proceed with completing the removable partial denture.

### *Corrected or altered cast*

This impression procedure is often required when the removable partial denture involves long-span distal extensions or long-span anterior edentulous areas. These areas often require a secondary impression using a low-viscosity impression material that provides minimal displacement of soft tissues and provides an accurate cast for fabrication of the acrylic resin denture base.

Following the fitting of the framework, the altered cast procedure can be accomplished. In the dental laboratory, the frame is replaced on the master cast and acrylic resin tray material is adapted to the metal framework over the denture-bearing areas. The primary pressure-bearing areas such as the buccal shelf, pear-shaped pad, and maxillary tuberosities are covered. Internal relief allowing the free flow of impression material is most often provided by grinding approximately 1.0 mm of the tray material from the secondary pressure-bearing areas such as the mandibular ridge crest and the mylohyoid ridge. Alternatively, pink wax can be adapted to the cast as relief before the acrylic resin tray material is adapted. Light-cure acrylic resin tray material such as Triad (Dentsply, York, PA) allows quick fabrication. The acrylic resin trays adapted on the framework can now be border molded in the mouth using green stick compound. After placing the appropriate adhesive, a final impression using a thin viscosity polyvinylsiloxane material can be used for the final impression. In the laboratory, procedures can be accomplished to make a more accurate altered cast (Figure 4.3.7).

### *Maxillomandibular records*

These records can be made at the same appointment as when fitting the framework.

### *Facebow transfer*

A facebow transfer records the position of the maxilla on three planes in relation to the temporomandibular joint. Most often the temporomandibular joint axis is arbitrarily located and transferred to an articulator. Mounting the patient casts with a facebow allows more accurate placement of the removable partial denture


a


b

**Figure 4.3.7.** (a) A metal framework with adapted acrylic resin is border molded and a final impression made for corrected cast procedure. (b) The corrected cast provides an accurate model with limited displacement of soft tissue.

teeth in the articulator and minimizes occlusal interferences when the dentures are placed in the mouth.

### *Interocclusal records*

If the patient casts cannot be accurately hand articulated, interocclusal records must be made. Recording mediums can be of a wide variety, but most often will be wax or a quick-setting polyvinylsiloxane bite registration material (Blue-Mousse, Parkell, Edgewood, NY). If the edentulous area is tooth borne or short span, the registration material can be placed directly into the framework denture base retention areas and the patient told to bite in a centric occlusion position. If the edentulous areas are tissue borne or long span, a light-cured denture base material with wax occlusal rim can quickly be made to provide support to the interocclusal registration material (Figures 4.3.8a and b). The metal framework with attached record bases is placed in the patient's mouth. There should be no contact between one occlusion rim and the opposing teeth or occlusion rim. The rims are then indexed with V-shaped notches. An interocclusal recording medium is placed on the record bases and the patient guided into centric occlusion or centric relation as determined clinically. There should be 1 mm interocclusal space to provide space for the interocclusal recording medium. Protrusive and lateral records can be made to allow setting the articulator condyles.

## Selection of teeth

Following the framework try-in, selection of color and size of acrylic resin denture teeth can also be made. It is recommended to use a shade guide of the actual teeth to be placed, as conversion guides from one shade guide to another can often be inaccurate. One example shade guide is Bioblend (Dentsply, York, PA).

Various sizes of anterior and posterior denture teeth can be found on denture mold charts provided by individual manufacturers. The selected color and size of desired pontic denture teeth should be recorded on the laboratory prescription.

## Next clinical appointment

The follow-up clinical appointment should be anticipated and planned accordingly. If corrected or altered cast procedures were accomplished, the next appointment would include maxillo-mandibular records and selection of teeth as noted above. Following the accomplishment of these procedures, several routes are pos-

a





b

**Figures 4.3.8a and b.** An acrylic resin record base with wax occlusion rim is adapted onto the metal framework to facilitate making interocclusal records.

sible. If no anterior teeth are involved and only short-span edentulous spaces are being restored, the pontic teeth can be confidently set in the laboratory and the removable partial denture can be processed to completion. Otherwise, a wax try-in appointment to verify the correct placement of teeth may be required.

## *Wax try-in*

A wax try-in composed of the metal framework, record base and occlusion rim, and the set denture teeth may be desired if anterior teeth are included in the restoration. This provides an opportunity for both the dentist and patient to view and approve the esthetic size, color, and arrangement of the anterior teeth (Figures 4.3.9a–c). Individual teeth can be examined for incisal edge position, facial contour, and lingual contour. Lip support, tooth length, midline, and horizontal and vertical overlap should also be verified. Phonetic inspection can be accomplished using sibilant "S" sounds to assess proper vertical dimension of occlusion, as well as fricative "F" sounds to assess proper length of incisal edges.

A wax try-in can also be accomplished to verify jaw relation records for long-span restorations. A try-in can be accomplished whenever interocclusal problems are encountered or if doubts exist concerning the accurate mounting of casts. Other reasons for accomplishing a wax try-in are if the removable partial denture opposes a complete denture, if all posterior teeth in both arches are being replaced, or if no



**Figures 4.3.9a–c.** A wax try-in of the set teeth is indicated when there is a need to view the esthetic arrangement of anterior teeth or to verify the interocclusal relationship of posterior teeth.

opposing natural teeth are in contact and there is a need to verify the vertical dimension of occlusion.

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## 4.4 The trial appointment

Often there is no need for additional try-in appointments after the metal framework has been evaluated and adjusted in the mouth (Figure 4.4.1). This is generally true for removable partial dentures that are tooth supported, replacing only a few posterior teeth. Further evaluation of the denture tooth set-up is required in instances in which it is necessary for both the patient and clinician to review and verify esthetics, phonetics, occlusion, patient tolerance, and anatomic limitations.

### Esthetic evaluation

For patients with a high esthetic concern, it is prudent to do an esthetic wax try-in prior to processing the acrylic resin (Figure 4.4.2). The shade, size, and shape of replacement teeth should be compatible with the surrounding dentition as well as with patient desires. At times it is difficult to reconcile the difference in perspectives between the patient's desire for "light and bright" and the dentist's charge to provide a removable prosthesis that is in harmony with the remaining natural dentition.

An instance where a dentist might be able to satisfy a patient's desire for replacement teeth that are lighter in shade than the surrounding dentition is when all the maxillary incisors will be replaced. Since the canines are often slightly darker (more chroma, less value) than the incisors in the natural dentition, a lighter shade for the incisors may produce a pleasant result.

When selecting replacement teeth for the maxillary anterior area, it is customary to distribute



**Figure 4.4.1.** In the case of tooth-supported RPDs, a try-in is usually not necessary.



**Figure 4.4.2.** It is wise to try in this RPD with extension base and anterior pontics prior to processing.

the edentulous space among the prosthetic replacements, that is, select a tooth size to fit the remaining edentulous area (Figures 4.4.3–4.4.6). If further information is needed, the relationship between the size of the maxillary central incisor and mandibular central incisor may be used following mathematical criteria as described (Tables 4.4.1 and 4.4.2). Studies by McArthur found that the maxillary central incisor is 1.62 times the width of the mandibular central incisor. In restoring large maxillary edentulous spaces, the maxillary canine-to-canine width is 1.3 times the width of the mandibular anterior teeth. Shillingburg et al. reported that the mean maxillary central incisor width was 8.5 mm, the lateral incisor was 7 mm, and the canine was 7.4 mm.



**Figure 4.4.3.** Multiple missing teeth suitable for a removable partial denture.



**Figure 4.4.4.** Esthetics of RPD pontics in harmony with remaining dentition.



**Figure 4.4.5.** Since the viewer's eye is attracted to the symmetry of the centrals and laterals, a slight shade difference between the canines and incisors is often unnoticeable.



**Figure 4.4.6.** Prosthetic teeth are compatible with remaining dentition. Central incisors take precedence and should be identical in size. The denture tooth selected to replace tooth no. 10 is slightly smaller in dimensions as compared to the contralateral incisor.

**Table 4.4.1.** Relative tooth width.

| Tooth | Male | (mean) | Female | (mean) |
|---|---|---|---|---|
| Maxillary central incisor | 1.0 | (8.59 mm) | 0.94 | (8.06 mm) |
| Maxillary lateral incisor | 0.78 | (6.7 mm) | 0.73 | (6.3 mm) |
| Maxillary canine | 0.87 | (7.5 mm) | 0.82 | (7.0 mm) |

**Table 4.4.2.** Relative tooth length.

| Tooth | Male | | Female | |
|---|---|---|---|---|
| Maxillary central incisor | 1.0 | (10.19 mm) | 0.92 | (9.39 mm) |
| Maxillary lateral incisor | 0.85 | (8.7 mm) | 0.76 | (7.79 mm) |
| Maxillary canine | 1.0 | (10.06 mm) | 0.87 | (8.89 mm) |

These measurements produced relative widths of central incisor, lateral incisor, and canine of 1, 0.82, and 0.87, respectively. In the mandibular arch the mean width of the central incisor was 5.5 mm, the lateral incisor was 6.0 mm, and the canine was 6.7 mm. The relative widths of the mandibular central incisor, lateral incisor, and canine were 1, 1.09, and 1.22. Similarly, Magne et al. found that the relative widths of the maxillary central incisor, lateral incisor, and canine were 1, 0.78, and 0.87, respectively. Sterrett et al. found that Caucasian females had mean widths of maxillary central incisor, lateral incisor, and canine that were smaller than those of Caucasian males by a factor of 0.94, 0.93, and 0.94, respectively. These measurements and ratios can be useful in choosing the mold of the replacement teeth for a removable prosthesis.

The location of the maxillary midline is critical for successful esthetics (Table 4.4.3). A midline that is not in harmony with the facial midline can doom the appearance of the removable restoration. Sometimes patients will report dissatisfaction with the appearance of their prosthesis without actually being able to provide a specific reason. It is imperative to check the midline at the try-in or at least transfer it to the master or opposing cast (Figures 4.4.7a and b).

**Table 4.4.3.** Esthetic evaluation checklist.

| | | | |
|---|---|---|---|
| Shade of teeth | Too light | Correct | Too dark |
| Size of teeth | Too small | Correct | Too large |
| Shape of teeth | Too bold | Correct | Too soft |
| Position of maxillary midline | Too far to left | Correct | Too far to right |
| Angle of maxillary midline | Angled to left | Correct | Angled to right |
| Labiolingual flare of maxillary incisors | Too labial | Correct | Too lingual |
| Neck of maxillary canine | Too prominent | Correct | Too recessed |
| Size relationship between maxillary and mandibular anterior teeth | Maxillary incisors proportionately too large/small | Correct | Mandibular incisors proportionately too large/small |
| Labiolingual flare of mandibular incisors | Too labial | Correct | Too lingual |



a



b

**Figures 4.4.7a and b.** These identical photos show how an errant midline spoils an otherwise esthetic arrangement.

## Phonetics

Although wearing a new prosthesis will likely require some speech adaptation, it is wise to perform a speech evaluation when multiple anterior teeth will be replaced (Table 4.4.4). As fricative ("f" and "v") sounds are made by the patient, the maxillary incisors touch the wet-dry line of the lower lip (Figure 4.4.8).

As the patient makes the "s" sound, the maxillary and mandibular incisors should just miss contact (less than 1 mm is ideal). However, in some instances, patients are able to provide the proper air escape at slightly greater distances. These patients are generally skeletal Class II patients (Figure 4.4.9)

**Table 4.4.4.** Phonetics evaluation.

| Sound | Expected Result |
|---|---|
| Labiodental fricative ("f" or "v") | Maxillary incisors touch wet-dry line of lower lip. |
| Sibilant ("s") | Mandibular incisors are less than 1 mm behind and less than 1 mm below maxillary incisors. |
| Bilabial consonant ("m") | Adequate lip seal. |
| Palato-alveolar fricative ("sh," "ch," "j") | Mandibular incisors are labiolingually even with and less than 1 mm below maxillary incisors. |
| Interdental fricative ("th") | Anterior portion of tongue touches lingual and incisal surfaces of maxillary incisors. |

## Occlusion

In general, if a patient's existing occlusion is functional and symptom-free, that occlusal scheme is retained when replacing missing teeth. Canine guidance occlusion appears to provide the least stress to the musculature and reduces lateral forces on the posterior teeth. Therefore, from a physiologic standpoint, a canine guidance occlusion is preferred over group function or other occlusal schemes with posterior contacts in eccentric movements.

If a removable partial denture is treatment planned and will be made opposing a complete denture (usually a maxillary complete denture prosthesis), then a complete denture occlusion must be considered when restoring the entire occlusal scheme. Complete denture occlusal schemes include using anatomic, semi-anatomic, or non-anatomic (flat plane or monoplane) prosthetic teeth in a balanced or non-balanced prosthetic tooth arrangement. Anatomic teeth will generally blend better with the existing occlusion—both functionally and esthetically—than



**Figure 4.4.8.** Maxillary incisors contact wet-dry line of lower lip when making the "f" sound.

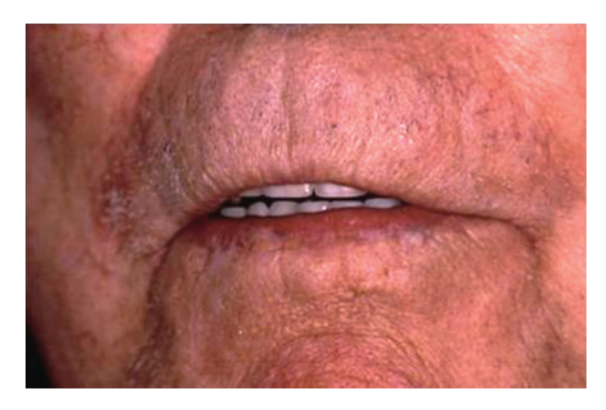


**Figure 4.4.9.** In making the "s" sound, the maxillary and mandibular incisors are out of direct incisal contact, with generally less than 1 mm of space between incisal edges.

non-anatomic teeth. A balanced occlusion is generally indicated if the RPD opposes a complete denture. Due to the cuspal inclines present, anatomic prosthetic teeth are easier to balance than non-anatomic teeth.

Lingualized occlusion offers many of the advantages of the anatomic balanced occlusal scheme as well as advantages of the simpler, non-anatomic scheme. The lingualized occlusion gets its name from the fact that the maxillary lingual cusp is the major functioning element (Figure 4.4.10).

Although there are variations on this occlusal scheme, the most popular entails a balanced occlusion in which the maxillary posterior teeth are anatomic or semi-anatomic and the mandibular teeth are flat or contain a shallow fossa. According to Parr and Loft, this occlusal scheme provides very good esthetics (since the maxillary anatomic teeth, particularly the first premolars, are visible), good bolus penetration, and denture stability (due to balance on the inclined planes). The tooth arrangement is simpler, easy to adjust, and provides an area of closure. These attributes make this a very versatile occlusal scheme that can be used in Class II and Class III jaw relations. If the opposing dentition has natural teeth or anatomic pontics, anatomic teeth should be used in the new prosthesis. If the opposing arch contains a complete denture, then corresponding denture teeth are generally provided in the RPD.

There is no simple solution in determining which occlusal scheme should be used. The dentist must decide if stability of a removable prosthesis takes precedence over what would be considered the ideal occlusal relationship that would provide harmony for the musculature and temporomandibular joint. For example, if a mandibular RPD opposes a maxillary complete denture, then a balanced occlusal scheme would be indicated in order to keep both prostheses seated in excursive movements. If an RPD replaces only a few teeth, the existing occlusal scheme should be maintained. When possible, nonworking contacts are avoided on natural posterior teeth. If one side of the arch has anterior and canine guidance, it is preferable to do likewise with the RPD pontics. Some possible scenarios adapted from Henderson place emphasis on RPD stability and are listed in Table 4.4.5.

## Choice of materials

Acrylic resin pontics are the teeth of choice for most patients. Current cross-linked polymers resist abrasion and are compatible with opposing occlusal surfaces of enamel or metal. However, if the RPD pontics oppose porcelain restorations, consideration should be given to more wear-resistant materials such as metal occlusal surfaces or porcelain denture teeth. Since porce-





**Figure 4.4.10.** Lingualized occlusion has the maxillary lingual cusp as its major functioning element. It is wise to perform a wax try-in for this bilateral distal-extension RPD.

**Table 4.4.5.** Possible scenarios adapted from Henderson.

| Arch to Be Treated with RPD | Opposing Arch Occlusion | Recommendation (Default) |
|---|---|---|
| Kennedy Class I (bilateral distal extension) or Class II (unilateral distal extension) | Complete denture | Full (working, non-working, protrusive) balanced occlusion |
| Kennedy Class I | Kennedy Class I RPD | Working, non-working balanced occlusion |
| Mandibular Kennedy Class I or II | Natural or restored dentition | Working balanced occlusion |
| Maxillary Kennedy Class I | Natural or restored dentition | Working, non-working balanced occlusion |
| Maxillary Kennedy Class II | Natural or restored dentition | Working balanced occlusion |
| Kennedy Class III (tooth borne) | Complete denture | Full balanced occlusion |
| Kennedy Class III | Natural or restored dentition | Anterior/canine guidance |
| Kennedy Class IV | Complete denture | Full balanced occlusion |
| Kennedy Class IV (short span) | Natural or restored dentition | Anterior/canine guidance |
| Kennedy Class IV (long span) | Natural or restored dentition | Protrusive balanced occlusion or full balanced occlusion |

lain teeth are attached to the denture base by mechanical retention, they require additional interocclusal space when compared to acrylic resin denture teeth, which have the ability to bond to the denture base. Some patients also report unnatural sounds—for example, “clacking”—when porcelain denture teeth oppose each other. Hirayama et al. recommend that custom glass ceramic occlusal surfaces be fabricated and cemented to prepared acrylic resin denture teeth in order to reduce the wear caused by opposing ceramic occlusal surfaces.

### *Need for occlusal evaluation prior to processing*

In patients with limited remaining dentition it is wise to perform a wax try-in to verify that the occlusion established in the articulator matches that of the patient. Repositioning teeth in wax is much more time-efficient than performing extensive grinding on the pontics of the completed removable partial denture to establish the proper occlusal relation (Figures 4.4.11 and 4.4.12).



**Figure 4.4.11.** Although this is primarily an error in diagnosis, a wax try-in might have eliminated the need for a remake of the RPD. The second molar pontic and denture base fractured due to inadequate space for metal retention, denture tooth, and acrylic resin denture base.

## Patient tolerance

A wax try-in or the trial appointment can determine if a patient will be able to tolerate planned changes to the conventional location and bulk of the prosthesis. Providing the appropriate amount of labial flare and an esthetic profile are additional concerns during the trial appointment. When restoring a large anterior edentulous space, it is wise to verify a patient’s lip support prior to completing the prosthesis. Optimal esthetics achieved with tooth placement and denture flange needs to be balanced with patient comfort. The trial appointment also affords the

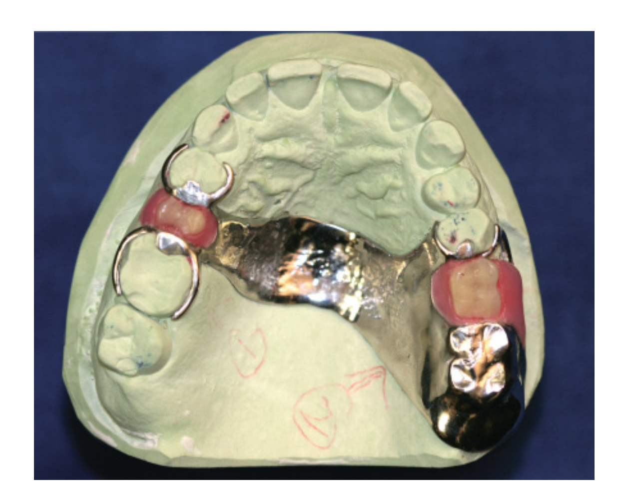


**Figure 4.4.12.** A new prosthesis with a combined metal base and metal pontic solved the problem. At the patient's request, the anterior-posterior extent of the framework was reduced for comfort. However, this change entailed the loss of the beneficial indirect retainers on the canines.

dentist the opportunity to evaluate the comfort of the major connector. Some designs such as a narrow palatal strap or anterior-posterior strap permit the patient to experience the sensation of food and temperature on the palate, whereas complete palatal coverage minimizes these sensations. Occasionally, extreme gaggers will have difficulty with a major connector that approaches the vibrating line of the soft palate.

Ordinarily, a large volume of acrylic in the labial flange area would be considered severely overcontoured, but this overdenture RPD camouflaged a midfacial deficiency associated with cleft lip and palate (Figures 4.4.13–4.4.15). Note that the replacement teeth placed over the overdenture abutments are in harmony with the opposing occlusion (Figure 4.4.15 and Figures 4.4.16a and b). Although maxillary and mandibular midlines do not coincide, the maxillary midline does coincide with the midline of the face. A slight asymmetry of the lateral incisors and prominence of the necks of the canines provide a natural appearance.



**Figure 4.4.13.** Patient presents with a midfacial defect and compromised midfacial support.



**Figure 4.4.14.** Due to the midfacial defect, there is also compromised midfacial, labial support that could benefit from a removable prosthesis in which additional resin can be contoured to affect the extraoral support.

## Anatomic limitations

In order to protect the residual ridge, proper coverage by the denture base provides a "snowshoe" effect that limits the amount of stress applied to any particular area under the denture base. This is true of both arches, but especially so for the mandible, which is known to resorb at a rate much greater than the maxilla. Due to muscle insertions present in the pear-shaped or retromolar pad, this structure plays a vital role in protecting the alveolar ridge anterior to it

from premature resorption. Typically the entire pad is covered by the denture base, to provide protection for the ridge. Also, extending denture base coverage laterally onto the mandibular buccal shelf provides similar protection for the residual ridge. It is also recommended that the denture base cover the external oblique ridge to form a seal with the mucosa covering the adipose and loose connective tissues that overlie the attachment of the buccinator muscle. Additional areas of concern in the mandibular arch include the remaining portions of the buccal and lingual vestibules, floor of the mouth, and the space required for proper function of the tongue in chewing, swallowing, and speech.

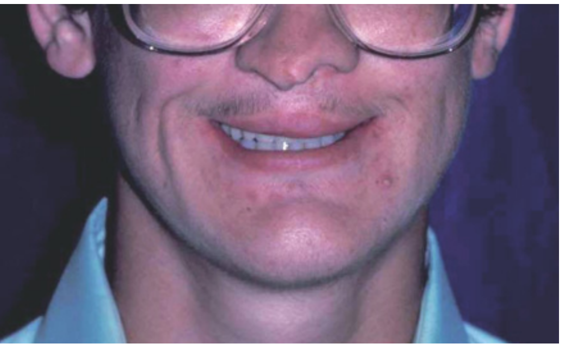


**Figure 4.4.15.** Ordinarily, this volume of acrylic in the labial flange would be considered severely overcontoured, but this overdenture RPD camouflaged the midfacial defect and aided in creating more labial support to maximize esthetic results.

In another patient scenario, it was not possible to cover the retromolar pad in the conventional manner. The opposing maxillary tuberosity limited the amount of tissue coverage over the retromolar pad. In the event that a pendulous tuberosity provides an interference that prevents any coverage of the retromolar pad, the maxillary tuberosity should be surgically reduced (Figures 4.4.17 and 4.4.18).

Similarly, in the maxillary arch, anatomic limitations that require circumvention or interceptive surgery are the height of muscle and frenum attachments. It is difficult to fabricate a well-fitting framework to an extremely high palatal vault. In this instance it may be necessary to limit the extent of the palatal coverage in order to achieve a satisfactory fit. Proper extension of the maxillary distal-extension base should reach the pterygomaxillary (hamular) notch. This structure should be identified by intraoral palpation rather than by inspection of the master cast.

a



b

**Figures 4.4.16a and b.** (a) Frontal view of the final RPD prosthesis demonstrates the prosthetic teeth have been set in harmony with the opposing occlusion. (b) Although maxillary and mandibular midlines do not coincide, the maxillary midline does coincide with the midline of the face. A slight asymmetry of the lateral incisors and prominence of the necks of the canines provide a natural appearance.



**Figure 4.4.17.** On initial appearance, the wax-up appears incomplete in that it was not extended to cover the entire retromolar area, excluding a portion of the retromolar pad.



**Figure 4.4.18.** The wax try-in confirmed that there was inadequate space for conventional coverage of the retromolar area. Some patients decline additional adjunctive surgical intervention such as a tissue reduction in the maxillary tuberosity region.

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# 5 Postinsertion Patient Care

## 5.1 Prosthesis insertion and maintenance

### Removable partial denture insertion

A sequential approach to removable partial denture insertion—the "delivery" appointment—is recommended and includes the following:

- Final inspection of the prosthesis before insertion.
- Verifying the removable partial denture (RPD) framework fit.
- Assessment of acrylic resin denture base adaptation.
- Assessment of peripheral extension of the denture base.
- Evaluating occlusion.
- Adjusting retentive clasp assembly, if needed.
- Providing instructions for the patient in the use and care of the prosthesis.

### Final inspection of the prosthesis

Prior to the insertion appointment, the dentist should check and adjust following:

1. Nodules of acrylic resin on the tissue surface of the prosthesis: The simplest way to locate these nodules is to run a finger over the intaglio surface (tissue side) of the prosthesis. Once identified and marked, the nodules can then be removed with a small, acrylic bur mounted in a slow-speed handpiece. When the nodules have been removed, do not polish the intaglio (tissue) surface; leave the surface finish as processed against the master cast.
2. Surface and internal porosity in the acrylic resin reduces both the quality and ultimate strength of the completed RPD. A porous surface will be difficult to keep free of dental plaque. A rebase of the RPD is recommended.
3. Examine denture teeth for fractures that may have occurred during the processing or finishing procedures. Replace fractured teeth before the RPD is inserted.
4. Evaluate the denture tooth–acrylic resin junction. If the junction of the denture tooth and acrylic resin denture base is improperly contoured and finished after processing, any crevices left in this area will become a potential site of food entrapment or staining.
5. Examine the acrylic resin/metal framework junction. The junction should be a butt (90°) joint with no overlap of the acrylic resin onto the metal framework. All acrylic resin flash should be removed so there is a smooth, continuous transition between the two materials



**Figure 5.1.1.** Acrylic resin flash beyond metal finish line.

(Figure 5.1.1). The denture borders should exactly duplicate the borders recorded in the master cast. Do not overly trim, smooth, and polish these areas. Loss of border fit may encourage food entrapment underneath the RPD.

6. Finally, inspect the finish and polish of the RPD. A poorly finished and polished prosthesis may unfavorably affect the patient's attitude toward the dentist and diminish patient-dentist rapport. The polished surface contours should have a smooth, high-luster appearance without surface blemishes; that is, a new appearance.

Store the RPD until the insertion appointment in a plastic bag partly filled with mouthwash and then heat sealed. This will keep the prosthesis moist to prevent dehydration and possible distortion of the acrylic resin base until the prosthesis is inserted.

## Seating of the removable partial denture framework

It is highly recommended to fit the cast metal framework intraorally before the insertion appointment. Regardless, the completed RPD should be carefully inserted into position on the abutment teeth. If there is considerable resistance to seating, stop and check for the following problems:

1. Clasp assemblies or other components of the framework may have been bent or distorted.

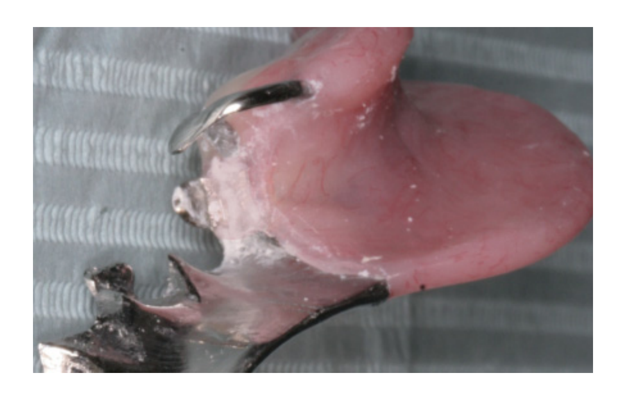


**Figure 5.1.2.** Acrylic resin on guide plane and rest preventing seating of the prosthesis.



**Figure 5.1.3.** Circled area indicates acrylic resin on tissue surface of the major connector that may prevent complete seating of the prosthesis.

2. Acrylic resin may have been cured into undercuts adjacent to the abutment teeth, preventing the uniform seating of the prosthesis (Figure 5.1.2).
3. A layer of acrylic resin flash may be covering part of the metal casting (Figure 5.1.3). Remove the acrylic resin before attempting to seat the RPD. A sharp dental explorer or dental floss can be used to check for the complete seating of the occlusal rests. There should be an intimate fit between the teeth and retentive clasp assembly (Figure 5.1.4).

If the occlusal rests on the prosthesis do not seat completely in their respective rest seat prep-



**Figure 5.1.4.** Note intimate contact between the rests and rest seats on the abutment tooth. Disclosing wax can be seen and is used to evaluate the fit of the framework.



**Figure 5.1.5.** The arrow points to an area that requires additional adjustment to allow complete seating of the framework, as noted in Figure 5.1.4.

arations, a minor discrepancy in the cast metal framework can be identified and corrected (Figure 5.1.5). If incomplete seating is not caused by the cast metal framework, then the processed acrylic resin portion of the prosthesis must be at fault. This may require a reline, rebase, and/or remake.

## Evaluation of denture base adaptation

When the cast metal framework has been fully seated, fit the acrylic resin portions of the prosthesis. An accurately fitting acrylic resin denture base is a primary consideration in the comfort and acceptance of an RPD. Excessive pressure may lead to discomfort, pain, and soft-tissue damage. A common contributor to excessive pressure is the dimensional changes that occur




**Figure 5.1.6.** Commercially available pressure indicator paste dispensed in a dampen dish to be applied with a disposable bristled brush.



**Figure 5.1.7.** Striations created in pressure indicator paste with the brush as illustrated.

in the acrylic resin denture base during processing. Apply pressure indicator paste (PIP) evenly on the intaglio (tissue) surface of the prosthesis with a stiff, short, coarse-haired brush (Figure 5.1.6). A coarse brush will leave thin brush marks on the acrylic resin surface that displace under pressure. Apply an even, thin layer of PIP to register pressure areas. Striations should appear as shown in Figure 5.1.7 prior to insertion. After the RPD is inserted, place cotton rolls between the teeth, and ask the patient to close lightly onto the cotton rolls. This will provide a functional loading of the soft tissue without introducing a potential occlusal interference.

Correct interpretation and adjustment of pressure areas indicated by the PIP are important.

Figure 5.1.8 demonstrates the appearance of PIP upon seating of the RPD. Figure 5.1.9 indicates an area to be relieved using an acrylic bur. After an area has been carefully reduced with acrylic burs, reapply PIP and reseat under finger pressure or the patient biting on cotton rolls. Adjustments are made until displacement of PIP appears only in the primary stress-bearing areas. There should be little or no paste distortion in areas that require relief or are not stress-bearing (incisive papilla, tori, mylohyoid ridge, crest of the mandibular residual ridge, median raphe, etc.).

## Assessment of denture base peripheral extensions

The peripheral borders of the denture base have a direct bearing on retention, stability, and patient comfort. Overextension of the prosthesis denture borders may cause the following:

- The muscles and frena will tend to dislodge the RPD during function. The resultant dislodging force may be transferred to the abutment teeth by the retentive clasp assemblies. These forces may be especially destructive when the denture base borders of a bilateral distal-extension RPD are overextended. The longer the distal-extension base, the longer the lever arm, and the greater the potential for



transmitting destructive forces to the supporting structures of the abutment teeth.
- Denture base overextension may cause ulceration, pain, and swelling of the vestibular tissues. If this is not corrected, over an extended period of time, redundant tissue may form in the vestibule as a response to chronic irritation.
- Impingement on the muscles of mastication may interfere with muscle function during mastication and speech.
- Denture border extensions of modification spaces may interfere with the complete seating of the RPD (Figure 5.1.10).



**Figure 5.1.9.** The circled area indicates an area to be relieved using an acrylic bur.



**Figure 5.1.8.** Pressure indicator paste partially displaced during seating of the prosthesis.



**Figure 5.1.10.** Red lines indicate areas to be reduced to allow seating of the prosthesis.

Underextended denture borders may cause the following:

- Inadequate distribution of masticatory force. The denture base should cover the retromolar pads and buccal shelf area to the external oblique ridges to obtain maximal support for the RPD.
- Food may collect under the tissue surface of an RPD and be an annoyance and/or an irritation.
- The prosthesis may lack stability. Underextended denture borders will not satisfactorily resist lateral or horizontal stresses.

Evaluating the denture base extension:

1. Observe intraorally the denture borders of the RPD. Have the patient open the mouth just wide enough to observe the denture borders. Overextension is usually easily detectable, because the mucosal tissues will be displaced by the denture borders pressing into the soft tissues. Underextension can be observed by very lightly deflecting the border tissues with the fingers and then letting the tissues return slowly to their relaxed position.
2. Use external palpation with the index finger. This is an especially effective method that uses applied pressure on the outside of the face over the region of the external oblique ridge. When the buccal flange of a mandibular RPD is overextended in this area, the dentist can feel that border extending out beyond the external oblique ridge.
3. Where it is difficult to observe border extensions, apply PIP or disclosing wax to the RPD borders (Figure 5.1.11). The prosthesis is then placed in the mouth, several drops of water are placed on the patient's tongue, and the patient is asked to swallow. Any areas of overextension will be visible where the wax or paste has been flattened or displaced by muscle action. The use of disclosing wax or PIP is especially effective on the distobuccal border of a mandibular RPD, which is controlled by the masseter muscle (Figure 5.1.12).



**Figure 5.1.11.** Disclosing wax applied to the denture base periphery prior to evaluating denture border extension.

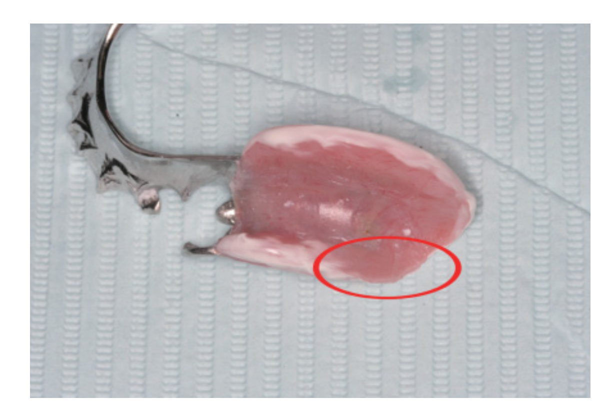


**Figure 5.1.12.** The circled area demonstrates disclosing wax being displaced during function. This area will require border extension reduction.

The most common areas of overextension of a maxillary RPD are the tissue side of the distobuccal flange and continuing through the pterygomaxillary notch area (Figure 5.1.13).

Common undercut areas are located inferior to the mylohyoid ridge, in the canine and premolar fossae, and in the retromylohyoid space. Recent extraction of either maxillary or mandibular anterior teeth will leave bony undercuts at the incisive and canine fossae. Relieve denture bases to allow the prosthesis to be inserted and withdrawn over undercuts without injury to underlying tissues. Adjustment can be accomplished in two ways. The first is by selective

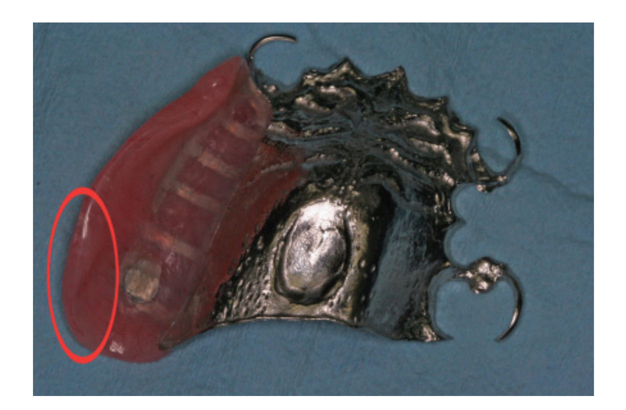


**Figure 5.1.13.** The circled area indicates a border extension to be carefully evaluated for undercuts and overextension of the denture base.

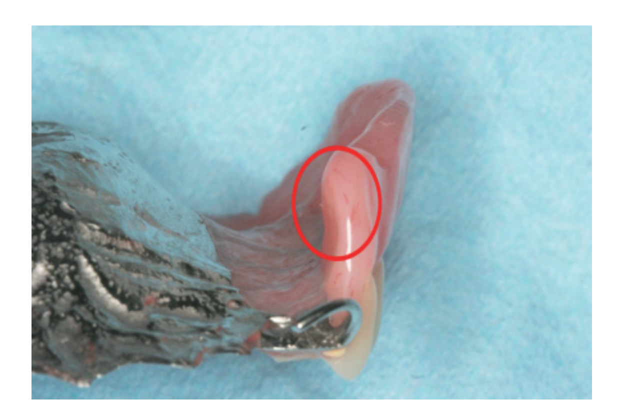


**Figure 5.1.14.** The circled area represents an area that will require vertical relief to allow the atraumatic placement and removal of this maxillary removable dental prosthesis.

grinding of the tissue-fitting surface of the denture base over the undercut area; the second is by compression of the mucoperiosteum and its subsequent relaxation when the RPD is inserted. If either of these methods fails to allow the prosthesis to be inserted and withdrawn in an atraumatic manner, vertical reduction of the denture flange may be indicated (Figure 5.1.14).

To properly contour a denture base in an anterior modification space, retract the lip and move it to the left and right while observing the movement of the frenum into the acrylic resin notch. The acrylic resin notch may need additional width and/or, more commonly, depth modification to accommodate the labial frenum. The



**Figure 5.1.15.** Often the vertical height of a maxillary denture border will require reduction. Additionally, the thickness may require careful thinning to reduce bulk to provide an acceptable profile and contour.

patient's face should be examined from both the frontal and profile views to determine if the lips are properly supported in repose and function. Adjust any excess vertical height and bulk with acrylic burs (Figure 5.1.15).

## Occlusal adjustment

Denture tooth arrangement for the prosthesis should be accomplished to provide bilateral simultaneous contact at the maximal intercuspal position (MIP). At the try-in visit, the maxillomandibular relationships and the esthetic and phonetic arrangement of the denture teeth are verified. Therefore, the occlusal adjustment of the RPD following processing of the denture bases should involve only minor processing changes. Processing changes can be corrected with a laboratory remount of the prosthesis before removal of the master cast.

Minor interceptive occlusal contacts can be corrected by selective grinding adjustments, which are made after the contacts are marked with articulating paper (Figure 5.1.16). If gross premature occlusal contacts are noted, a new interocclusal (centric relation) record should be made. Remount the RPD on a dental articulator and make the necessary occlusal corrections by selective grinding at an acceptable vertical



**Figure 5.1.16.** Minimal occlusal adjustments may be accomplished chairside with a small round bur in a slow-speed straight handpiece. However, if more extensive occlusal correction is required, a remount procedure is recommended.

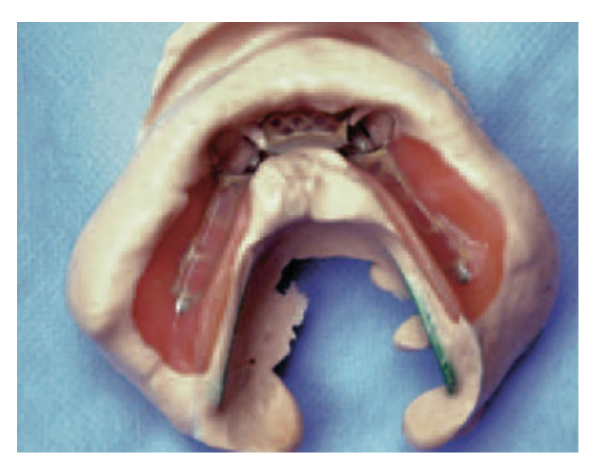


**Figure 5.1.17.** A pickup impression in irreversible hydrocolloid impression material (alginate) may be used to fabricate a remount cast for more extensive occlusal corrections.

dimension of occlusion. This is accomplished outside of the mouth and away from the patient. The same method is used for opposing prostheses. The clinical remount is the most efficient method of adjusting occlusion because it allows direct observation during adjustment.

## Remounting the prosthesis

The master cast is usually destroyed when the RPD is finished and polished. To obtain an accurate remount cast to correct occlusal disharmonies, make an intraoral irreversible hydrocolloid (alginate) impression of the prosthesis correctly positioned on the supporting tissues; that is, a pickup impression (Figure 5.1.17). The remount cast will include both the natural teeth and the prosthesis, which can then be mounted on a dental articulator against a stone cast of the opposing dentition by means of a new centric relation record (Figure 5.1.18). Correction of major occlusal discrepancies might require removal of the denture teeth from the prosthesis, resetting of the same or new denture teeth, scheduling of another patient try-in visit, and reprocessing of the RPD. Minor occlusal disharmonies can be corrected by selective grinding.



**Figure 5.1.18.** This is a remount cast proposed by Hsu and Farmer that allows removal and reseating of the prosthesis during the occlusal correction procedure. This cast is mounted on an articulator with an interocclusal record to orient a cast of the opposing dentition.

If there are no observable premature contacts when the patient occludes, articulating paper is used to determine if there are any deflective occlusal contacts. Intraorally, using occlusal indicator wax is another method of registering major interceptive occlusal contacts. The goal in occlusal adjustment is to eliminate all deflective occlusal contacts and provide evenly distributed, simultaneously balanced occlusal contacts on both the natural teeth and denture teeth at the vertical

dimension of occlusion (OVD). Following any occlusal adjustment, the anatomic features of the artificial teeth should be restored to maximum efficiency by redefining the grooves and embrasure spaces and repolishing of the teeth.

## Postinsertion adjustment procedures

Postinsertion problems tend to be minimized when a sequential insertion procedure, as previously described, is followed. However, problems may occur as the result of one or any combination of comfort, function, esthetics, and phonetic difficulties.

Areas of tissue trauma may develop the first few days after insertion of an RPD. A generalized soreness over the residual ridge crests can be caused by patient habits, such as clenching or grinding. To detect parafunctional habits, engage the patient in casual conversation and observe him or her. Usually when patients clench their teeth together firmly, a marked, prolonged contraction of the masseter and temporalis muscles can be observed. Patients should be made aware of the problem and educated about it.

A differential diagnosis of a burning sensation is determined by the location of the problem. The most common area for a localized burning sensation to occur is the anterior hard palate. Pressure on the incisive papilla can occur when the RPD is first inserted, or it can occur subsequently during function. Usually the incisive papilla will appear reddened because of the pressure from the prosthesis. Selective grinding of the denture base in this area will usually correct any anterior burning sensation. A burning sensation located on the posterior hard palate is corrected by reduction of pressure over the posterior palatine foramen.

Tongue and cheek biting is more prevalent when monoplane (0°) posterior denture teeth are used than when cusped denture teeth are used. Monoplane posterior denture teeth can easily be arranged with no horizontal overlap. This lack of horizontal overlap allows the soft tissues of the tongue and cheeks to become trapped between the denture teeth during mastication or swallowing, leading to painful ulcerations. The problem can be corrected by reducing the lingual or buccal surfaces of the maxillary or mandibular denture teeth, allowing the unaltered opposing denture tooth to hold the soft tissues away from the occlusal surfaces of the teeth.

Lip biting is generally caused by improper placement of mandibular teeth in relation to the maxillary teeth. Usually, recontouring the labial surfaces of the mandibular canine teeth will eliminate the problem. Observing the patient can determine whether lip biting is caused by habit. Counseling can often correct the problem.

It is often necessary to differentiate between an allergic reaction caused by denture materials and an irritation that is caused by an ill-fitting denture or poor oral hygiene. An allergic reaction may be primarily suspected when all tissues, tongue, cheeks, and denture-bearing areas that come in contact with the acrylic resin denture base or metal framework, are fiery red. However, true allergic reactions are extremely rare. In contrast, an ill-fitting denture, fungal infection, or poor dental hygiene will cause redness limited only in the denture-bearing areas.

There are at least eight causes for temporomandibular disorder (TMD) pain. If pain occurs in the temporomandibular joint (TMJ) initially or shortly after the RPDs are inserted, the cause may be either a reduced OVD (absence of adequate interocclusal distance) or centric occlusion that is not in harmony with centric relation. When properly diagnosed, either of these errors is correctable. However, pain caused by arthritis or trauma is more difficult to diagnose and treat. Arthritis pain or pain caused by trauma usually has a previous history and will not require treatment with a new prosthesis.

Numerous functional complaints can arise after the patient has used an RPD for varying periods of time. There are several recurring reasons for the complaint that can include

- Insufficient retention of the prosthesis and denture border overextension.

- Incorrect vertical dimension of occlusion (OVD).
- Interceptive occlusal contacts.

### *Insufficient retention and denture border extension*

Bilateral distal-extension RPDs are inherently less stable than all tooth-supported RPDs because there are no posterior abutment teeth that can be used for retention and support. The remaining natural teeth must be used judiciously for retention or the physiologic limits of supporting structures will be exceeded. The capacity of an abutment tooth to be maintained over a prolonged period of time is compromised by excessive overloading from this type of prosthesis. If the RPD dislodges during function, the temptation is to deepen the retentive undercut for the retentive arm of the clasp assembly and bend the retentive arm into the deepened undercut. Not only does this place a greater stress on the abutment tooth and its supporting structures; but half-round cast clasps cannot be adjusted edgewise to increase or decrease the retentive potential of a cast clasp.

An effective approach is to examine the denture base extensions by using disclosing wax during function to determine if they are overextended and thus causing the RPD to dislodge. Properly extended denture borders and intimate denture base–tissue contact minimize the retentive requirements of an abutment tooth. Over the long term, it is ultimately neuromuscular control rather than the influence of the direct retainers that is the key to successful RPD retention and function.

Incorrect occlusal vertical dimension is more often associated with problems of complete dentures (CDs) rather than with those of RPDs because of the inherent subjectivity involved in determining this dimension. However, the functional problems associated with an inappropriate OVD in an RPD are the same as those of a CD and will create similar patient difficulties.

The occlusion of an RPD is adjusted before and during the insertion phase of patient treatment. However, occlusion is a dynamic entity. The natural teeth shift and the denture bases adapt to the resilient denture-bearing tissues. The result of these changes, coupled with continual residual ridge reduction, is that interceptive occlusal contacts continue to recur for the majority of patients as long as the prosthesis is used.

Interceptive occlusal contacts are the most frequent causes of instability of an RPD during its functional use. One interceptive occlusal contact on one side of the dental arch can cause the RPD to be displaced from the tissues on the opposite side of the dental arch and give the patient a "rocking" sensation. Occlusal adjustment is an ongoing maintenance procedure that must be performed at all recall visits. It is a necessary procedure to maintain the continued oral health of all patients treated with RPDs.

### *Swallowing and gagging*

Problems associated with swallowing can be caused by a number of factors. One is the overextension of the mandibular denture base in the retromylohyoid space, or a too-thick polished surface contour of the prosthesis in that region. A maxillary RPD may cause swallowing difficulties if it is overextended posteriorly or if its posterior border is excessively thickened. An increased or grossly decreased OVD can also contribute to patient swallowing difficulties. Placement of posterior denture teeth in lingual version is another possible cause of swallowing problems.

The problems associated with swallowing can also cause physiologic gagging on insertion of the prosthesis. However, if a gagging problem is absent immediately after insertion of the RPD and the physiologic gagging occurs several weeks to months following insertion, salivary entrapment under the prosthesis may be the cause. An imperfect posterior denture border seal or malocclusion may cause the RPD to allow saliva to

enter between the mucosa and the prosthesis, triggering the patient's gag reflex.

### Food collection on the borders

Proper contouring and tapering of the peripheral borders are important to prevent collection of food on the borders. However, there are some peripheral borders that must be left thick to fill in space and support the facial musculature. Such is the case when the maxillary distobuccal vestibule is wide.

Food can adhere to the RPD if it is poorly contoured or not well polished, or if the patient has a diminished salivary flow. There are multiple commonly prescribed and over-the-counter medications that may contribute to reduced salivary flow and quality. Advise the patient during patient appointments. Recommend to compensate for it by drinking more fluids when eating. High polish of acrylic resin will cause chewing gum to stick to the surface. Usually, removal of the high polish with flour of pumice and a rag wheel will correct the problem.

### Functional problems with no specific symptoms

If the patient states that the RPDs do not feel right but has no specific symptoms, the dentist must suspect that an incorrect OVD, incorrect centric relation or other malocclusion, maladaptation to the prosthesis, or some combination of these problems is the cause. Reevaluating the OVD, recording new interocclusal records, and remounting the prosthesis to correct the difficulties may be helpful.

### Esthetics

Replacement of anterior teeth with an RPD may pose esthetic complications. Esthetic problems are especially pronounced for the patient with a short, active upper lip who displays a large amount of tooth and residual ridge when smiling. Matching anterior denture teeth with natural teeth requires proper attention to shade control, characterization of the contours of the denture teeth to harmonize with the natural teeth, and correct denture tooth positioning. Correct lighting in the dental treatment room is an important factor in shade selection, because the incidence of refraction of light by the natural teeth will not be the same as that for artificial teeth.

A poor esthetic result in an RPD can be caused by

- The occlusal plane being either too low or too high.
- The incorrect labiolingual and axial inclination of the denture tooth position.
- Failure to create an adequate "smile line."

Additionally, the patient's expectations of the esthetic result may be far beyond the anatomy, physiology, and morphology of the orofacial structures of the patient. Often older people will request that vertical wrinkles radiating out from the lips be eliminated. This would often require that the teeth be placed too far labially. Patient counseling and close attention to the patient's desires can often lead to successful treatment of unhappy, discouraged patients. There is a challenge to restoring an esthetically acceptable appearance. Although some patients will never psychologically accept loss of their teeth, others, with proper treatment and care, can be successfully treated.

### Phonetics

The majority of RPDs will not produce any appreciable adverse effects on patient speech patterns or sounds. However, the loss of maxillary anterior teeth or extensive loss of maxillary posterior teeth will change the anatomy of the maxillary dental arch. Replacement of the missing teeth, major connector placement, dental arch form, and denture base contour can either detract from or enhance the ability of the patient's tongue to function effectively in the production of speech sounds.

It is difficult to determine the source of speech problems at the try-in stage because (1) the pros-

thesis is new for the patient, and (2) the tongue and lips do not assume the same position when in contact with wax as they do against a finished and polished acrylic resin denture base.

### *Phonetic problems associated with RPD treatment*

Whistling on "s" sounds can indicate that the anterior part of the tongue is being crowded by the maxillary premolars, which constricts the tongue groove necessary to carry expelled air down the center of the palate. This forces the air to whistle through a smaller than normal space. By addition of a ridge of acrylic resin to the palatal portion of the prosthesis in this region, the flow of air will be cut down and the whistling stopped. Lisping on "s" sounds may indicate too small an air space or improper tooth position functionally related to the mandibular anterior teeth. Therefore, the palatal portion of the prosthesis must be thinned or the denture teeth repositioned.

When "th" and "t" sounds are indistinct, there is usually inadequate interocclusal distance. This can be corrected by thinning the maxillary prosthesis or both maxillary and mandibular denture bases lingually and also by reducing the lingual surface of the premolars. If the "t" sounds are similar to the "th" sounds, the anterior denture teeth have been positioned too far lingually.

In normal "f" and "v" sound production, the maxillary anterior teeth contact the "wet-dry" line of the lower lip at its highest point. If these sounds are indistinct, the maxillary incisors must be repositioned either vertically or horizontally to their proper positions.

The following tables (Tables 5.1.1–5.1.4) may act as a quick reference guide to the problems previously presented as postinsertion findings.

**Table 5.1.1.** Postinsertion concerns about discomfort and potential causes.

| Concern | Cause |
|---|---|
| Tissue trauma | |
| In vestibules on the posterior limit of maxillary RPD | ■ Overextended denture borders<br>■ Posterior palatal seal too deep<br>■ Sharp posterior denture border<br>■ Overextension on highly mobile soft palate |
| Single areas of tissue trauma over residual ridges | ■ Interceptive occlusal contacts<br>■ Inaccurately fitting denture base<br>■ Acrylic resin nodules<br>■ Movement of denture on bony eminences<br>■ Thin mucosal covering |
| Generalized soreness over residual ridges | ■ Vertical dimension of occlusion too great; inadequate interocclusal distance<br>■ Inaccurately fitting denture base<br>■ Parafunctional habits (such as bruxism) |
| Pain at distobuccal denture border | ■ Impingement on masseter muscle during function |
| Pain under lingual bar or at lingual peripheries | ■ Overextension of lingual denture border<br>■ Lingual bar too low, impinging on lingual frenum or floor of mouth<br>■ Deflective occlusal contacts |
| Pain and swelling of gingival tissues | ■ Lingual denture borders too close to teeth<br>■ Pressure on lingual gingival tissues<br>■ Lack of adequate oral hygiene |
| Painful abutment teeth | ■ Interceptive occlusal contacts on abutment teeth<br>■ Interceptive occlusal contact on one or more denture teeth<br>■ Rest or clasp exceeding physiologic limits of abutment tooth tolerance<br>■ Interceptive occlusal contact on rests<br>■ Unstable denture bases<br>■ Insufficient interocclusal distance |

Continued

**Table 5.1.1.** *Continued*

| Concern | Cause |
|---|---|
| Burning sensation | |
| In anterior hard palate and anterior residual ridge areas | ■ Pressure on anterior palatine foramen |
| In maxillary premolar to molar area | ■ Pressure on posterior palatine foramen |
| In mandibular anterior residual ridge | ■ Pressure on menial foremen |
| Tongue, lip, or cheek biting | ■ Overclosure (excessive interocclusal distance)<br>■ Posterior denture teeth set without horizontal overlap<br>■ Posterior denture teeth set too far buccally or lingually<br>■ Posterior teeth set too far distally<br>■ Improper position of anterior teeth<br>■ Patient habits |
| Fiery redness of all tissues contacted by RPD | ■ Denture base material allergy (rare)<br>■ Excessive residual acrylic resin monomer<br>■ Fungal infection |
| Redness of denture-bearing areas | ■ Ill-fitting RPD<br>■ Fungal infection<br>■ Inadequate oral and denture hygiene |
| TMJ pain | ■ Insufficient occlusal vertical dimension<br>■ Centric occlusion not in harmony with centric relation position<br>■ Interceptive occlusal contacts<br>■ Referred pain from sensitive abutment tooth<br>■ Arthritis<br>■ Trauma<br>■ Patient habits (bruxism, clenching)<br>■ Overextension of distobuccal border of maxillary prosthesis |

Adapted from Morstad, A.T., Petersen, A.D. 1968. Postinsertion denture problems. *J Prosthet Dent* 19:126.

**Table 5.1.2.** Postinsertion concerns about function and potential causes.

| Concern | Cause |
|---|---|
| Instability of prosthesis when not occluding | ■ Insufficient engagement of retentive areas by arms of direct retainers<br>■ Insufficient number of retentive abutment teeth<br>■ Overextension of RPD borders<br>■ Hypermobile tissues displaced when impressions were made now rebound |
| Instability of prosthesis when incising food | ■ Insufficient engagement of retentive areas<br>■ Poor support under anterior denture teeth<br>■ Incorrect incising habits of patient |
| Instability of prosthesis when masticating food | ■ Interceptive occlusal contacts on individual teeth: on one side of dental arch; in premolar area<br>■ Poorly designed clasp assemblies<br>■ Redundant tissue on residual ridge<br>■ Centric occlusion not in harmony with centric relation |
| Interference with swallowing | ■ Posterior denture teeth set too far lingually<br>■ Distolingual border (retromylohyoid area) of mandibular RPD overextended<br>■ Distolingual border (polished surface) of mandibular RPD too thick, interfering with pterygomaxillary ligament and palatoglossal muscle<br>■ Distal border of maxillary RPD too thick<br>■ Distal border of maxillary RPD overextended<br>■ Excessive or insufficient vertical dimension of occlusion |

**Table 5.1.2.** *Continued*

| Concern | Cause |
|---|---|
| Gagging<br>On insertion of RPD | ■ Overextension of maxillary RPD<br>■ Posterior border of maxillary RPD too thick<br>■ Distolingual border of mandibular RPD too thick<br>■ Psychological rejection of prosthesis<br>■ Inadequate retention of RPD |
| Gagging<br>Delayed (2 weeks to indefinite time after insertion) | ■ Inadequate posterior palatal seal, allowing saliva under maxillary RPD<br>■ Lack of retention, allowing saliva under prosthesis |
| Teeth contacting during speech | ■ Excessive occlusal vertical dimension (insufficient interocclusal distance) |
| Functional problems with no specific symptoms | ■ Incorrect vertical dimension of occlusion<br>■ Interceptive occlusal contacts<br>■ Incorrect centric relation<br>■ Psychological rejection of prosthesis |

Adapted from Morstad, A.T., Petersen, A.D. 1968. Postinsertion denture problems. *J Prosthet Dent* 19:126.

**Table 5.1.3.** Postinsertion concerns about esthetics and potential causes.

| Concern | Cause |
|---|---|
| Upper lip distorted or unsupported | ■ Anterior denture teeth placed too far lingually<br>■ Maxillary anterior denture base too thin (unsupported) or too thick (distorted) |
| Excessive anterior denture tooth display | ■ Occlusal plane established too low<br>■ Canines and lateral incisors arranged with excessive prominence<br>■ Lack of adequate "smile line"<br>■ Anterior denture teeth too large for dental arch segment<br>■ Excessive occlusal vertical dimension (interocclusal distance insufficient) |
| Fullness under nose | ■ Maxillary anterior denture base too thick or overextended |
| Poor esthetics: anterior artificial teeth not in harmony with natural teeth | ■ Incorrect size and position<br>■ Incorrect characterization<br>■ Poor color selection<br>■ Poor blending of acrylic denture base with natural gingivoalveolar anatomic features<br>■ Patient expectations too great |

Adapted from Morstad, A.T., Petersen, A.D. 1968. Postinsertion denture problems. *J Prosthet Dent* 19:126.

**Table 5.1.4.** Postinsertion concerns about phonetics and potential causes.

| Concern | Cause |
|---|---|
| Whistle on "s" sounds | ■ Too narrow an air space on the anterior part of palate |
| Lisping on "s" sounds | ■ Too broad an air space on anterior part of palate |
| Indistinct "th" and "t" sounds | ■ Inadequate interocclusal distance |
| "t" sounds like "th" | ■ Maxillary anterior denture teeth set too far lingually |
| Indistinct "f" and "v" sounds | ■ Improper position of maxillary anterior teeth (either vertically or horizontally) in relation to lower lip |

Adapted from Morstad, A.T., Petersen, A.D. 1968. Postinsertion denture problems. *J Prosthet Dent* 19:126.

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## 5.2 Repairs and relines

### Postinsertion care—repairs and relines

For the RPD patient, periodic evaluations and follow-up treatment and care are essential to successful wear and function of the prosthesis. The following areas are suggested as areas of interest to this success:

- Anatomic features of the residual ridges in both the mandible and maxilla (clinical and radiographic examination required).
- Soft-tissue health.
- Periodontal health status.
- Fit of the RPD framework.



**Figure 5.2.1.** The arrow illustrates an area of pressure necrosis manifested as a clinical leukoplakia associated with chronic trauma from an ill-fitting RPD.

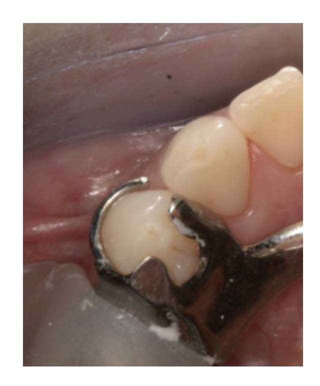


**Figure 5.2.2.** The retentive tip of the wrought wire clasp requires readaptation to retentive undercut.

- Denture base adaptation.
- Occlusion.

If the patient examination reveals soft tissue trauma (Figure 5.2.1) secondary to RPD wear, tissue recovery procedures may be required. This may include

- Tissue recovery—remove prosthesis as often as possible.
- Use of tissue-conditioning materials.*
- Fabrication of a temporary prostheses—normally limited to unmet esthetic demands.
- Occlusal adjustment.
- Nutritional counseling.
- Surgical intervention.

*For the patient who cannot or will not leave the RPD out of the mouth before the relining impression procedure is done, tissue-conditioning materials may be used as an adjunct to return the mucosal tissues to a non-inflamed state of health.

## Abutment teeth and the fit of the removable partial denture framework

Evaluate the framework fit by assessing the following: all clasp arms intact (Figure 5.2.2), occlusal rests of adequate thickness, and major connectors fitting properly. To determine the accuracy of fit, the RPD framework must be reseated in its originally designed position. When correctly positioned, depress the distal-extension denture bases. When residual ridge resorption has been severe, the RPD will rotate about an imaginary fulcrum line. When this rotation occurs, observe any indirect retainers anterior to this fulcrum line that are not in their designed position and the anterior portions of occlusal rests that are slightly rotated out of their rest seats. When rotation of the prosthesis occurs, note that the inferior portion of the lingual bar major connector may impinge on the lingual soft tissues. If these tissues have been chronically irritated, there may be hypertrophied tissue formed at this portion of the major connector. These rotational forces may also transmit destructive forces to the abutment teeth. One may observe radiographic changes associated with this or discover increased mobility of the abutment tooth.

## Fit and condition of the denture base

When a distal-extension RPD requires refitting, a space will exist between the distal-extension denture base and the soft tissue when the occlusal rests and direct retainers are seated in their designed positions. Evaluate the borders of the RPD for proper extension to provide maximum support of the prosthesis during the relining

procedure. The physical condition of the denture base should be evaluated. If acceptable, the denture base can support new acrylic resin. However, if the denture base is porous, has fractured, or is unesthetic, replace all the denture base by use of a rebasing rather than a relining procedure.

## Occlusion

Occlusion must be carefully examined when the mouth is closed and again when the occlusal rests are completely seated. Observe the occlusion when the RPD is properly oriented to the abutment teeth rather than in maximum intercuspation position (MIP); several differences may be noted: deflective occlusal contacts may have developed or there may be no occlusal contact between the RPD denture teeth and the opposing dentition. Potentially there may be traumatic anterior tooth contact due to the lack of posterior tooth support. Therefore, occlusal equilibration should be accomplished after relining or rebasing procedures to distribute occlusal loading of the natural teeth and the RPD denture teeth through bilateral simultaneous contact in MIP (Figures 5.2.3 and 5.2.4).

When there has been extrusion of opposing dentition, irregular wear, shifting of teeth, or reorientation of the occlusal plane (in the case of a maxillary complete denture), it is usually necessary to selectively grind the opposing dentition and possibly change some or all of the denture teeth on the RPD being relined or rebased. In cases of severe residual ridge resorption beneath a mandibular bilateral distal-extension RPD, occlusal contacts are so altered that either new denture teeth must be used or the existing ones, if still usable, must be repositioned on the denture base. If this is not done, the posterior denture teeth, in most instances, will need extensive occlusal grinding to achieve occlusal harmony. In most instances, this would destroy the posterior denture teeth. Consider the expense of time and laboratory fees before attempting such alterations versus fabrication of a new prosthesis.

## Rebasing, relining, and repairs

The loss of function of an existing RPD may be caused by

- Residual ridge resorption.
- Loss or modification of abutment teeth.
- Soft-tissue damage or change.
- Fracture of one or more of the various components of the prosthesis.



**Figure 5.2.3.** The circled area demonstrates tooth-to-tooth contact without the mandibular RPD in place.



**Figure 5.2.4.** The circled area demonstrates the same desired tooth-to-tooth contact with the RPD in place. Additionally, occlusal contacts between the denture teeth and opposing natural teeth should be assessed for uniform contact.

- Deterioration of the denture teeth or the denture base of the prosthesis.

## Residual ridge reduction and the removable partial denture

An RPD that no longer fits or functions properly may be discovered during a routine recall examination, but more frequently, the patient will seek help because of some sort of discomfort. Fracture of the framework, denture teeth, or acrylic resin denture base is usually obvious. However, residual ridge resorption often goes unnoticed due to the adaptive nature of many patients. Resorption occurs most rapidly in the first 6 months to 2 years postextraction of the teeth and subsequently proceeds at a slower pace until death. Therefore, even the most well-adapted prosthesis will require attention to maintain comfort, function, and esthetics due to continuing residual ridge resorption.

Common findings for any given RPD patient may include

- Loss of intimate soft-tissue contact with the prosthesis.
- Loss of occlusal contacts.
- Soft-tissue damage (such as ulceration, inflammation, or hypertrophy).
- Altered relationship of the clasps on the abutment teeth, leading to increased abutment tooth stress.
- Fracture of RPD components.
- Clinical signs of the "anterior hyperfunction syndrome."

The loss of RPD function as a result of changes in the bony support of the prosthesis will vary. The functional loads vary for each patient and for each partially edentulous arch. These variables include

- Amount, frequency, duration, and direction of the applied load.
- Force applied per unit area.
- Amount of occlusal contact area available.
- Amount of denture-bearing area available.
- Supporting soft-tissue quality.
- Supporting hard-tissue quality.
- Traumatic prosthodontic factors.

However, there is a discernable pattern to residual ridge resorption depending on the classification of the partially edentulous arches.

## Tooth-borne removable partial denture (Kennedy Class III)

In general, any given patient who has well-healed residual ridges (extractions more than 24 months ago) and is treated with a Kennedy Class III RPD will require the least amount of alterations to restore function. Functional loads are directed to the abutment teeth through the rest seat rather than the residual ridge; therefore, a tooth-borne RPD will have the least amount of residual ridge resorption. The tissue-fitting surface of this type of RPD, whether in the maxilla or mandible, will require the least amount of correction to maintain its function. Most corrections of the tooth-borne prosthesis are for esthetics or denture hygiene maintenance. However, if functional components have been significantly altered or lost, a reline or rebase procedure will not correct the discrepancy (Figure 5.2.5).



**Figure 5.2.5.** The loss of rests as vertical stops results in the loss of occlusal contacts and settling of RPD, leading to soft-tissue entrapment and trauma. Also, note that poor oral hygiene and maintenance are contributing factors to recurrent caries and soft-tissue inflammation and trauma.

## Maxillary distal-extension removable partial denture (Kennedy Class I)

The Kennedy Class I maxillary RPD is borne by both teeth and tissue with much of the functional load applied to the soft tissues and underlying residual ridge. However, a patient with well-healed residual ridges who is treated with a maxillary distal-extension RPD may need only occasional RPD correction. This has been found to be especially true when the hard palate rather than the residual ridges is used to support the RPD. Palatal support can be accomplished by use of a wide palatal strap or a complete-palate major connector.

## Mandibular distal-extension removable partial denture (Kennedy Class I)

The Kennedy Class I mandibular RPD commonly requires correction to restore function because it derives the majority of its support from the underlying soft tissues and residual ridges; the functional loads directed to the residual ridges through and by the prosthesis are the greatest of any type of RPD. When residual ridge resorption occurs in the mandibular arch of patients treated with a bilateral mandibular distal-extension RPD opposed by a maxillary complete denture, a combination of signs and symptoms often occurs.

Kelly described the “combination syndrome” as follows:

1. Residual ridge resorption in the anterior maxilla.
2. Downgrowth of the maxillary tuberosities.
3. Papillary hyperplasia over the hard palate.
4. Extrusion of the mandibular anterior teeth.
5. Mandibular residual ridge resorption.

In addition, Saunders, Gillis, and Desjardins described other associated changes often noted in these patients:

- Loss of occlusal vertical dimension.
- Occlusal plane discrepancy.
- Protrusive repositioning of the mandible.
- Poor adaptation of the prosthesis.
- Epulis fissuratum formation on the maxillary anterior residual ridge.
- Unfavorable periodontal changes.

When a patient is treated with this type of RPD, the patient must be educated about these changes and the need for follow-up care. Obviously, in any given clinical situation, if the patient is treated with an RPD soon after tooth extraction, residual ridge remodeling is of a greater magnitude than in a patient with well-healed residual ridges. This patient should be informed at the time of treatment planning of the need to refit the prosthesis as part of the treatment procedure.

## Procedures for reestablishing function of a removable denture prosthesis

### *Relining and rebasing*

In the vast majority of refitting procedures, relining an RPD is the most expedient treatment. RPD relining entails adding new base material (usually an acrylic resin material) to the existing denture base to restore the soft-tissue adaptation of the prosthesis.

Rebasing of a RPD is indicated when

- The denture base acrylic resin is esthetically or functionally unacceptable.
- Substantial denture border extension is necessary.
- Denture teeth must also be replaced on the RPD during the refitting procedure.

Rebasing procedures involve replacing the entire denture base with new base material to restore not only the tissue surface but also polished surface contours and to provide mechanical retention for new denture teeth if needed.

## Relining procedures using a simple addition impression technique

### *Tooth-borne removable partial dentures*

This type of RPD needs relining infrequently and usually only for hygienic or esthetic reasons. If the RPD framework fits properly—that is, all metal rests are completely positioned in their respective rest seats and direct retainers are in proper relation to the abutment teeth—the entire relining procedure is relatively simple. When it is carried out accurately, the dentist can anticipate little or no change in occlusion on the relined RPD.

The recommended procedure for relining a tooth-borne RPD is

1. Remove undercuts on the tissue surface of the RPD base completely using acrylic burs mounted in a slow-speed handpiece. Undercut removal will avoid fracture of the final dental stone cast during both the separation of the impression and the processing procedures.
2. Relieve an even layer of approximately 1 mm of acrylic resin denture base material from the tissue surface of the prosthesis with a large acrylic cutting bur mounted in a slow-speed handpiece. This relief will allow sufficient space for the impression material.
3. Correct any denture border extension as necessary; this should be accomplished with a suitable material such as modeling plastic (compound) or a polyvinylsiloxane before the impression procedure is accomplished.
4. A final impression is made using an elastomeric impression material such as polyether or a polyvinylsiloxane. In a tooth-borne RPD, either a closed- or an open-mouth impression technique is used to make the final impression. In either technique, be sure that the RPD framework is completely seated while the impression material is setting by observing the rest–rest seat relationship. Verify the impression material has not come loose and remove excess impression material.
5. Replace the final impression in the mouth in its correct position, and make a full-arch irreversible impression in a rim-lock or perforated stock tray. This impression relates the prosthesis to the remaining teeth. The set impression is removed and inspected to verify the relationship of the prosthesis to the remaining teeth.
6. Pour the impression with the RPD incorporated into it immediately with dental stone to create a working cast.
7. Separate the dental stone cast, with the impression of the RPD in place. The impression material is removed from the tissue-fitting surface and dental stone cast.
8. Process the tissue surface with new acrylic resin denture base material. Then finish and polish it.
9. Insert and adjust the RPD as previously described.

## Distal-extension removable partial dentures

The distal-extension RPD can be more difficult to reline or rebase than the tooth-borne type. Carefully consider the advantages and disadvantages of refitting an RPD versus remaking it, in terms of chair time required and the associated laboratory expense. With severe residual ridge resorption, the occlusion of the prosthesis is often so altered after relining that either new denture teeth must be used or, at least, the old ones must be repositioned.

When a maxillary complete denture opposes a mandibular RPD under whose distal-extension denture base severe residual ridge resorption has taken place, the signs and symptoms of the "combination syndrome" may occur. In this instance, there may be a profound alteration of the occlusal plane on both prostheses. Not only do the denture teeth on the RPD need to be replaced, but it also may be necessary to replace the maxillary complete denture (CD). In this case, it may be more time- and cost-effective to remake the maxillary CD and the mandibular

RPD rather than to attempt to either reline or rebase one or both prostheses.

The procedure for relining or rebasing a distal-extension RPD can be accomplished as follows:

1. Remove all undercuts on the intaglio (tissue) surface of the distal-extension denture base of the RPD using acrylic burs mounted in a slow-speed handpiece. Areas that most frequently require removal of undercut are the mylohyoid ridge and retromylohyoid fossa. Removing these undercuts in the denture base may prevent cast fracture when the prosthesis is separated from the stone cast to remove the impression material.
2. Remove an additional 1 mm of acrylic resin denture base material from the entire tissue-fitting surface of the prosthesis using acrylic burs in a slow-speed handpiece.
3. Correct any borders of the RPD that are improperly extended such as over the retromolar pads, mylohyoid ridge, or buccal shelf; correct them by using stick modeling plastic prior to the final impression.
4. Make the final impression with any of the elastomeric impression materials. However, an open-mouth impression technique must be employed when the impression is made; this allows observation of placement of the rests into their rest seats. Make certain that the rests are in their designed position on the abutment teeth and maintained in this position until the impression material sets. Finger pressure directly over the occlusal rests and indirect retainers should be maintained until the impression material sets. Importantly, at no time during the impression procedure should pressure be directed to the distal-extension denture base (Figure 5.2.6).
5. Remove the impression from the mouth and inspect for accuracy. The impression of the tissues must be accurate without impression material that has extruded between the abutment teeth and the metal components of the prosthesis. The impression may be reseated and an over-impression can be made with alginate impression material and then poured in dental stone to make a complete arch cast (Figure 5.2.7). The resulting dental cast can then be sent to the dental laboratory for either relining or rebasing as desired.
6. Note that if a polyvinylsiloxane impression material is used, a complete arch impression utilizing an alginate over-impression is not required. The resulting RPD reline/rebase impression can be sent directly to the dental

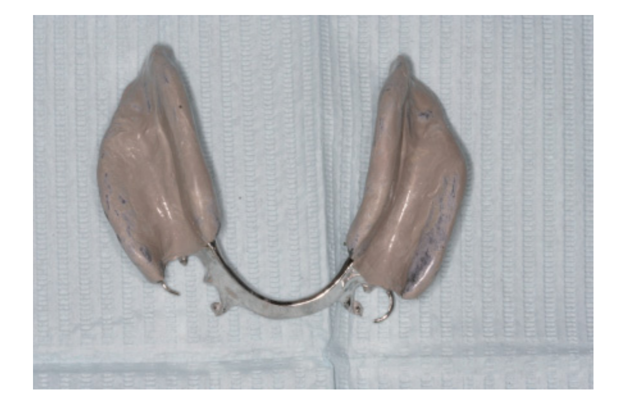


**Figure 5.2.6.** This mandibular RPD impression for a reline or rebase was made utilizing stick modeling plastic to correct the denture border extensions and light-bodied rubber base. Some show-through of the modeling plastic can be noted. These areas will need to be adjusted at delivery utilizing pressure indicator paste as discussed in the previous chapter.

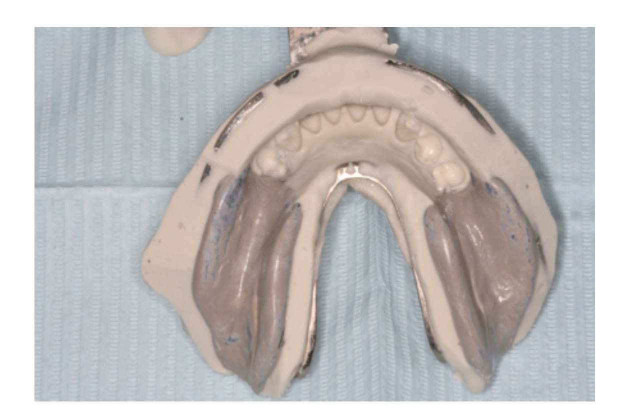


**Figure 5.2.7.** An over-impression was made to create a complete arch impression and is then poured in dental stone to create a complete arch cast. This technique is useful when making an altered cast for an RPD or a cast for rebasing or relining an existing RPD.

laboratory without pouring a dental cast. If minimal denture base correction is required by this procedure, then the occlusion of the prosthesis is usually altered only minimally, and judicious occlusal adjustment is all that is necessary to bring the RPD back to normal function.

Reestablishing function for an RPD when there has been significant residual ridge resorption is probably the most difficult refitting procedure to accomplish accurately. Loss of occlusal contact with the opposing teeth is a common finding due to wear and the ridge resorption. Often new denture teeth must be used on the RPD to reestablish an adequate occlusion.

In patients who exhibit severe residual ridge resorption, the RPD framework rotates about its fulcrum and, at a minimum, the indirect rests can be seen moving out of the rest seats (Figures 5.2.8a and b). Rotation may be to such a degree that the inferior portion of the major connector may impinge on the lingual alveolar tissues. This tissue compression usually causes ulceration or, if chronic in nature, the formation of hypertrophied tissue. Often this may be the patient's only complaint and the reason care is sought. When occlusal loads are exerted in the first molar region, the prosthesis rotates, causing the occlusal rests to leave the rest seats and the lingual bar to compress the lingual alveolar tissues. When the patient is asked to make light occlusal contact, a common finding is that the denture teeth on the distal extension are entirely out of occlusal contact.

If the occlusal discrepancy described exists, it is strongly recommended to remake the prosthesis.

The procedure for relining distal-extension RPDs when marked residual ridge resorption has occurred is presented as follows:

1. All undercuts are removed from the tissue-fitting surface of the distal-extension denture bases by the use of acrylic burs mounted in a slow-speed handpiece. In addition, the entire tissue surface of the RPD is moderately (1–2 mm) relieved.
2. Stick modeling plastic or other materials must be used wherever necessary to correct any deficiencies in the distal-extension denture base, such as denture border extension. Relate the RPD to the abutment teeth in its designed position. To ensure that the prosthesis is seated in its designed position while the denture borders are being corrected, press down on the occlusal rests, indirect retainers, and lingual plating while the border extensions are being corrected. Indirect retainers are important guides in


a


b

**Figures 5.2.8a and b.** The arrow in the left photograph demonstrates the indirect retainer seated in its designed position. The arrow in the right photograph demonstrates the indirect rest slightly lifting out of its rest seat when the distal-extension denture base is depressed, indicating the need to reline or rebase this RPD to improve the fit and support of the distal-extension denture base.

accurately orienting the framework in its proper relation to the teeth and soft tissues during a relining or rebasing procedure.

3. Border extensions should be corrected until the RPD denture base is stable and properly extended and the framework is completely seated in its designed position.
4. Any modeling plastic used for correction should be relieved by about 1 mm over the alveolar tissue if it is in tissue contact. This will allow the impression material to record the denture-bearing tissues in an uncompressed state. Modeling plastic in contact with the border tissues is not relieved when the impression is made.
5. The final impression is then made with an elastomeric impression material. The impression is made by use of an open-mouth impression technique while finger pressure is maintained on the lingual major connector and all occlusal rest areas until the impression material is set.
6. When fully set, the impression should be removed from the mouth and examined for accuracy. The distal-extension denture base area should be examined for pressure areas, voids, or distortion of the tissues. Examine the inferior surface of the occlusal rests for impression material that may have extruded under the rests and altered the fit of the framework. If any inaccuracies are found, the impression procedures should be repeated until a satisfactory impression is obtained.
7. When the completed impression is reseated intraorally and the patient is asked to close the mandible, a significant change in the articulation and occlusion may be observed. If this is the case, the denture teeth may need to be removed and reset.
8. To accomplish replacing the denture teeth, the occlusal portion of the distal-extension denture base should be trimmed until no opposing occlusal contact exists at an appropriate vertical dimension of occlusion. A centric relation record is made at an acceptable vertical dimension of occlusion.
9. An alginate over-impression is made in a stock tray over both the RPD and the remaining teeth, as illustrated in Figure 5.2.7. The resulting impression is poured with dental stone.
10. An alginate impression of the opposing dental arch is made and poured with dental stone. The opposing cast is mounted on a dental articulator by means of a facebow transfer procedure. The mandibular dental stone cast, with the RPD and impression in place, is articulated by means of the centric relation record. The mounted casts are sent to the dental laboratory for resetting the denture teeth and processing.
11. Insertion of the relined RPD should follow standard insertion procedures previously outlined. Final occlusal corrections are made on the RPD by making a new interocclusal record to remount the RPD on the articulator for final occlusal adjustments, as described in the previous chapter (Figures 5.2.8a and b).

When all of the steps have been accomplished, the sequence of relining and rebasing a RPD is similar to treating the patient with an entirely new RPD. Successful treatment is dependent on the adequacy of fit of the existing RPD framework.

## Repairs

Deciding to repair or remake an existing RPD is sometimes difficult. Consider before proceeding to treatment:

- The patient's financial status.
- The patient's physiological age.
- The frequency of appointments, which represents production time.
- The patient's medical status.
- The degree of difficulty of the impression-making procedures.
- The associated dental laboratory fees.

Some or all of these factors may influence the decision whether to repair or remake the pros-

thesis. Frequently, it is more expedient to remake an RPD than to devote the time, effort, and dental laboratory fees necessary to repair a framework that is marginally acceptable and may require replacement in the near future. Simple repairs or additions to an RPD can usually be accomplished with or without impressions. Many times, simple repairs can be accomplished in the dental office without outside dental laboratory support or expense.

### *Denture base repair*

Various types of RPD base breakage may occur, ranging from the complete loss of a denture base border segment to the fracture or loss of a portion of the denture base proper. In the former example, complete loss of a segment of the denture base border will require a rebasing or relining impression procedure. This procedure is presented in the following paragraphs.

1. A reline impression using an elastomeric impression material is made; the RPD acts as a tray. When an entire portion of the denture base is missing, the denture base must be corrected with autopolymerizing acrylic resin, stick compound, or both so that the impression material can be accurately carried into place (Figures 5.2.9 and 5.2.10).
2. The completed impression is boxed and poured with dental stone to secure a master cast.
3. The new denture flange segment is repaired with either autopolymerizing or heat-cured acrylic resin. Heat-cured acrylic resin repairs are best accomplished by a dental laboratory service.
4. However, the clinical procedures are similar to those used and illustrated in Figures 5.2.6 and 5.2.7 to produce a dental cast for the repair.
5. When the fractured segment of the RPD denture base is still available, the repair is a relatively simple in-office procedure. The fractured pieces are approximated and joined with sticky wax (Figure 5.2.11).
6. The tissue surface of the RPD is poured with dental stone. When the master cast is sufficiently hard, the RPD is removed and the junction of the segments is enlarged to approximately 2–3 mm in width.
7. A separating medium is applied to the working cast, and the RPD segments are replaced on the stone cast; the space of 2–3 mm created between the segments is for the repair acrylic resin (Figure 5.2.12).
8. Autopolymerizing acrylic resin is added in a “salt and pepper” fashion (sprinkled on) to the space between the approximating segments. The acrylic resin monomer and



**Figure 5.2.9.** This drawing represents an RPD with a fractured and missing distobuccal denture border. Reevaluate the fit of the prosthesis before proceeding with a repair. If the fit of the framework is inadequate, consider remaking the RPD.



**Figure 5.2.10.** This drawing represents the correction of the missing segment by using green stick modeling plastic prior to making a final impression for the repair. The clinical steps are now identical to a reline or rebase procedure.

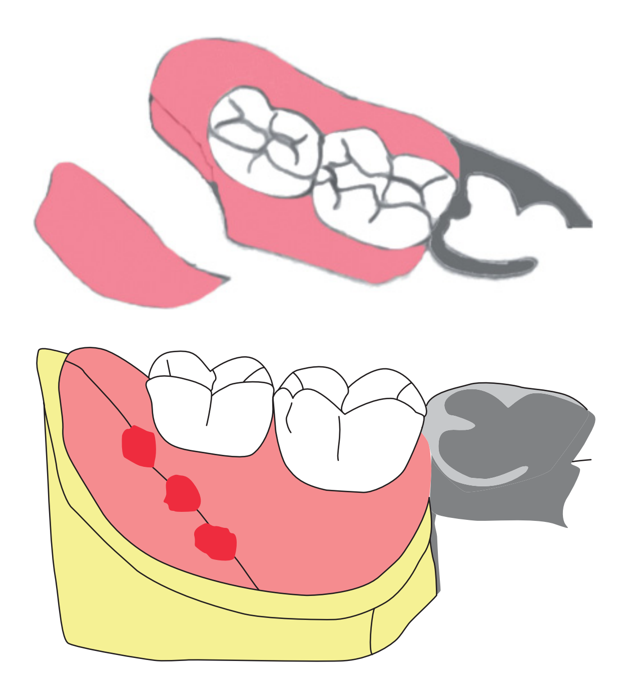


**Figure 5.2.11.** The upper illustration shows a fractured denture base with the segment still intact. Prior to making the stone quadrant cast, the two pieces are sticky waxed together, the tissue surface is lubricated, and then dental stone is poured against this surface to create what is shown in the lower illustration.

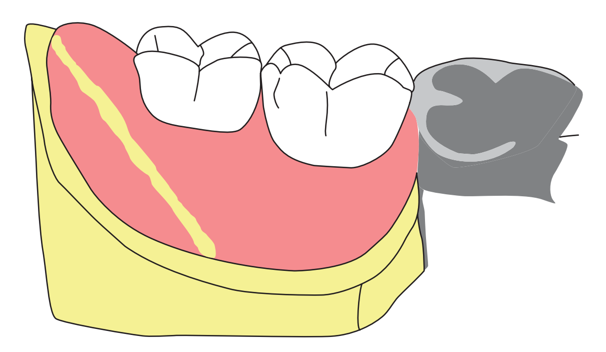


**Figure 5.2.12.** The two pieces are separated from this repair cast and a space is created for the autopolymerizing acrylic resin, separating medium is placed on the cast, and the pieces are reseated on the cast as illustrated.

polymer should be applied alternately until the repair site is slightly overfilled (Figure 5.2.13).

9. For a denser repair with less internal porosity, the RPD still on the dental stone cast should be placed in a temperature-controlled pressure bath at 30 p.s.i. at about 120 °F for 30 minutes (Figure 5.2.14).
10. The repair site is trimmed and finished with acrylic burs mounted in a low-speed handpiece. Polishing is carried out in a conventional manner, using the various grades of pumice and finally acrylic resin polish (Figures 5.2.15a and b).

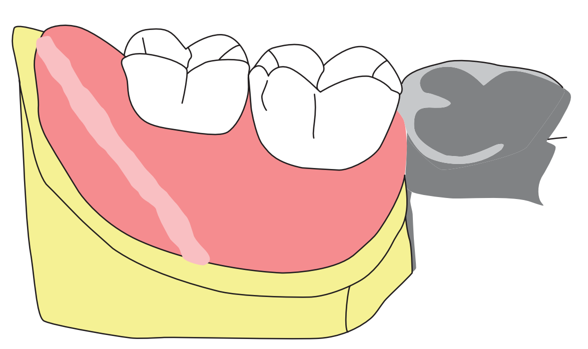


**Figure 5.2.13.** The lighter pink represents autopolymerizing acrylic resin that is slightly over-bulked to allow for polymerization shrinkage, finishing, and polishing.

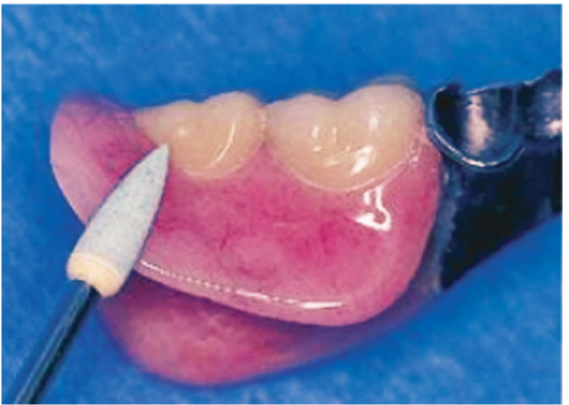


**Figure 5.2.14.** A pressure cooker or pressure pot is an effective method of curing autopolymerizing acrylic resin. A denser and stronger cure is possible compared to "air curing." However, heat-activated polymerized acrylic resin has greater density and strength than auto-cured polymerized acrylic resin.

## Repair of fractured denture teeth

There are two basic types of denture teeth used in RPD treatment: dental porcelain and acrylic





**Figures 5.2.15a and b.** The RPD should be carefully removed from the dental repair cast. Follow routine finishing and polishing procedures prior to inserting the repaired prosthesis.





**Figures 5.2.16a and b.** The left photograph shows an intact acrylic resin denture tooth that has been dislodged from the denture base. The right photograph demonstrates reseating the tooth in its proper position. Sticky wax is sometimes needed to stabilize the tooth; it should be added either facially or lingually away from the occlusal surface to provide space for the dental stone index shown in the next figure.

resin. Today, porcelain denture teeth are rarely used due to various limitations, such as no chemical bond to the acrylic denture base, they are difficult to adjust, and the potential to wear opposing occlusion. If the patient has porcelain denture teeth, it is best to consult with a dental laboratory service that can provide the necessary repair. However, the repair or replacement of acrylic resin denture teeth will be described.

The procedure for repair and replacement of acrylic resin denture teeth is as follows:

1. If an acrylic resin denture tooth is dislodged from a new RPD, the common cause is an incomplete chemical bond between the acrylic resin denture tooth and the acrylic resin denture base. This incomplete chemical bond may be caused by wax residue or oils left between the two acrylic resins when the RPD was processed.
2. Therefore, the denture tooth can normally be reseated in the denture base and autopolymerizing acrylic resin may be used to repair the RPD. Figures 5.2.16a and b through Figure 5.2.21 illustrate the series of steps to make this type of repair. Processing, finishing, and polishing are the same as described for the repair of the denture base.

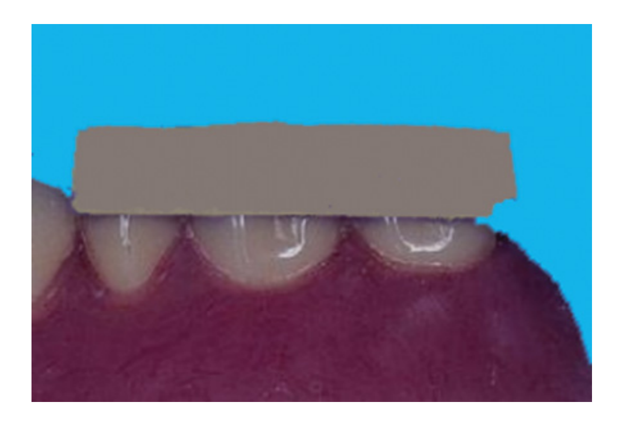


**Figure 5.2.17.** With the denture tooth secured in the correct position, a dental stone index is made utilizing a thick hand mix of stone and slurry water to accelerate the set of the stone. Be sure to lightly lubricate the occlusal surfaces of the teeth to facilitate removal of the index. In approximately 15 minutes, the index can be removed and trimmed as shown.



**Figure 5.2.18.** The stone index is removed, the denture tooth is removed and cleaned, and small retentive undercuts are provided (arrow) for mechanical retention as well as chemical bonding. Prior to reindexing the tooth to the denture base, both the mating surface of the denture tooth and denture base may be lightly brushed with monomer liquid to enhance the chemical bond.

3. When the acrylic resin denture tooth is abraded or fractured, a similar series of steps may be accomplished. The fractured or abraded tooth must be carefully cut out to create space in the denture base for a similarly sized new denture tooth. This should be accomplished at slow speed with an acrylic bur.

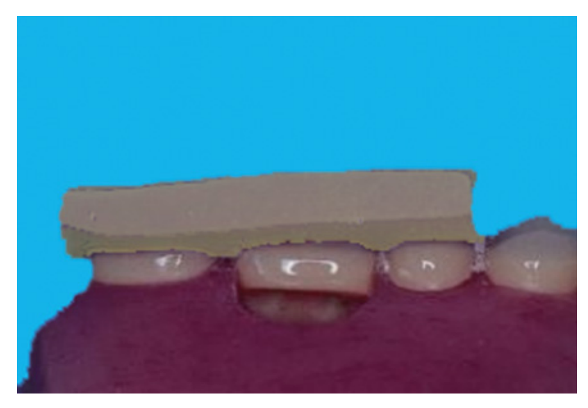


**Figure 5.2.19.** This lingual view shows the denture tooth reseated and stabilized by the stone index. Space has been created from the lingual to add the autopolymerizing acrylic resin. Be sure the index and denture tooth are completely seated before proceeding with resin addition. Sticky wax, again, may be used to secure the pieces.



**Figure 5.2.20.** Autopolymerizing acrylic resin powder and monomer liquid are added with a brush until the area is slightly over-bulked. Keep the area lightly moistened with monomer during this step.

4. A new denture tooth is selected, adjusted to fit the repair site, and checked to ensure that there is adequate room for the autopolymerizing acrylic resin.
5. The denture tooth is luted in position with sticky wax, an index is made as shown in Figure 5.2.17, and new autopolymerizing acrylic resin is applied, processed, and finished as previously described.
6. Occasionally the anterior denture teeth are positioned against the residual ridge to eliminate a denture flange. In these instances, when an anterior denture tooth is fractured, an impression must be made with the RPD in

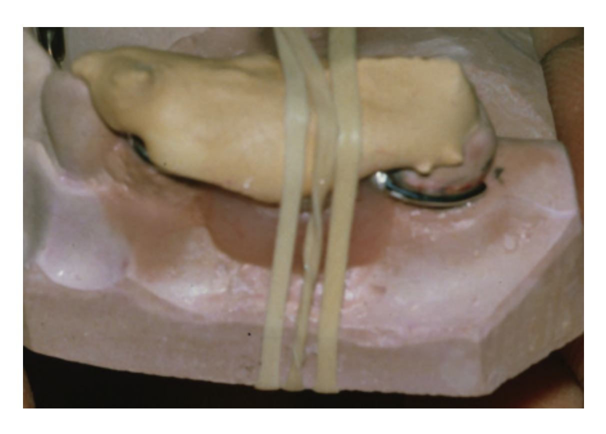


**Figure 5.2.21.** This photograph illustrates another similar repair to the previous figure. The stone index is secured with a rubber band before it is placed in a pressure pot for processing of the autopolymerizing acrylic resin.

place and the repair must be carried out to completion on a dental stone cast.

7. An alternate, temporary method to repair a fractured or lost denture tooth on an RPD is to add tooth-colored acrylic resin to the prepared defect site. The mass can be reshaped to simulate the denture tooth after polymerization of the acrylic resin is completed.
8. When denture teeth are repaired on an RPD, the occlusion of the RPD in centric and eccentric positions must be carefully checked and adjusted as necessary.

## Complex repairs

There are many complex repairs or modifications that can be made to a defective RPD. These include (1) repair or replacement of a clasp assembly or any part thereof, (2) repair of a major or minor connector, and (3) repair of the RPD after the loss of an abutment tooth. All complex repairs require the use of proper impression procedures by the dentist.

The most frequent type of component breakage on an RPD is the fracture of one or more parts of the clasp assembly (i.e., fracture of one or more clasp arms, the occlusal rest, or the area between the minor connector and the major connector). The cause of the fracture should be determined and corrected. If the design of the RPD was inadequate and stress on the RPD framework or parts of it was too great, then a new design and RPD are indicated. More commonly the fracture of the framework is caused by a patient or dentist mishandling the chromium-cobalt alloy (such as dropping the prosthesis, bending it on a dental lathe, or adjusting the clasp arm beyond the elastic limit of the metal).

A clasp arm is the RPD component that is most subject to fracture, and it can be repaired by either of two techniques: (1) by embedding an 18-gauge wire into the denture base of the RPD as a substitute clasp arm (Lu, 1983), or (2) by constructing a new clasp assembly and soldering or welding it to the existing RPD framework.

The procedure for repair of a broken clasp arm using a wire is presented as a repair that may be accomplished in the dental office on a selected basis. More complex situations will require dental laboratory services and the accompanying dental laboratory fee.

The following is a suggested indication and method for clasp repair.

1. The buccal retentive clasp of an RPD is usually the most commonly fractured or deformed framework component. An 18-gauge platinum-gold-palladium (PGP) or wrought wire can be used as an effective substitute to replace this retentive arm on the RPD.
2. The fractured RPD is placed in the patient's mouth and the position and fit are verified. An irreversible hydrocolloid (alginate) impression of both the RPD and the natural teeth is made in a stock tray. Ensure the RPD has not been dislodged from the natural teeth or pulled loose from the alginate impression (Figure 5.2.22).
3. This impression is poured immediately with dental stone to create a working cast on which the repair will be completed.
4. The fractured portion of the clasp arm is removed from the RPD framework. An area is created in the acrylic resin denture base to

mechanically retain the wire (Figures 5.2.23a and b).

5. The 18-gauge PGP or wrought wire is contoured to fit the contours of the dental stone replica of the abutment tooth, using orthodontic pliers. A retention loop is fashioned in the distal end of the wire so that it can be mechanically bound into the acrylic resin denture base.
6. The completed 18-gauge PGP or wrought wire is secured in place with sticky wax on the dental stone abutment tooth (Figures 5.2.24a and b).
7. Autopolymerizing acrylic resin can be added in "salt and pepper" fashion to complete the mechanical retention of the wire in the denture base.
8. The RPD, 18-gauge PGP or wrought wire, and autopolymerizing acrylic resin are cured in a temperature- and pressure-controlled curing unit in warm water (about 120 ° F) for 30 minutes at 30 p.s.i. (Figures 5.2.25a and b). The RPD is now ready for careful removal from the repair cast.
9. The new buccal retentive arm and acrylic resin are finished and polished. The RPD is checked intraorally for proper contact of the 18-gauge PGP or wrought wire arm into the retentive undercut. Adjustments are made when necessary to the wire to increase or decrease the frictional retention of the arm (Figures 5.2.26 and 5.2.27).

Additional repair methods for replacing a lingual reciprocal arm, broken occlusal rests, and replacing teeth that are extracted are

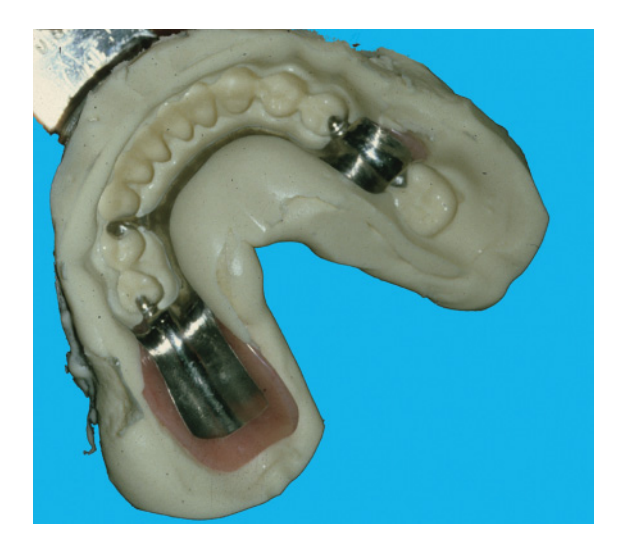
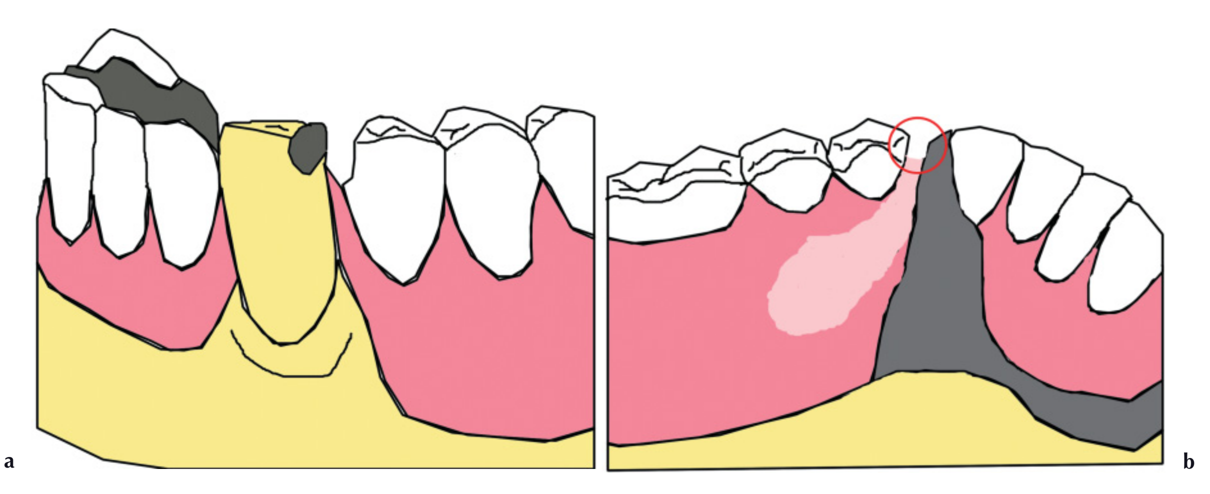
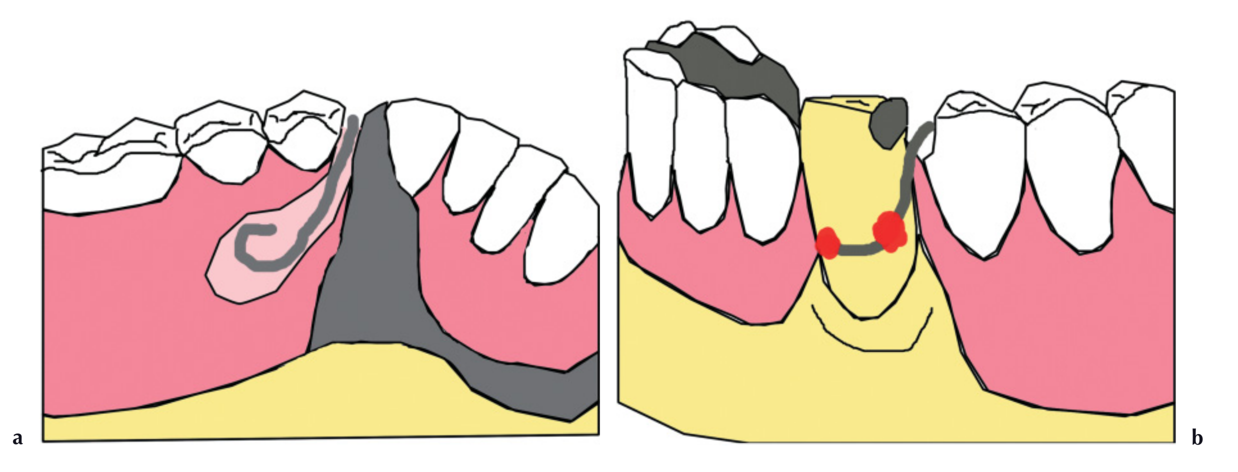


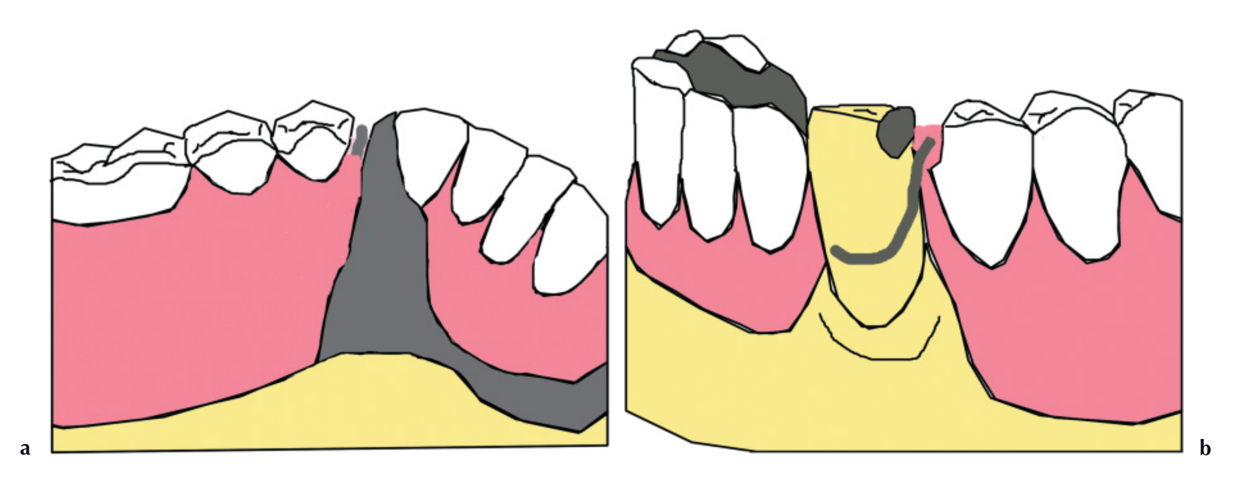
**Figure 5.2.22.** Note that the rests do not have a layer of impression material covering them. This indicates the rests were in intimate contact with their respective rest seats and the RPD was in its correct designed position. Also, note the RPD has not been dislodged from the impression material.




**Figures 5.2.23a and b.** The drawing on the left illustrates the RPD on the repair cast and the broken retentive clasp removed. The right illustration shows the space created for the wrought wire. The circled area depicts the space required to bring the wrought wire to the facial side for adaptation to the abutment tooth.



**Figures 5.2.24a and b.** The left illustration demonstrates the wrought wire adapted into the relieved space and a retentive loop to mechanically assist in retaining the wire. The wire must be placed into the denture base deeply enough to allow complete coverage with autopolymerizing acrylic resin without altering the cameo surface contour. The right illustration shows the wrought wire adapted to the abutment tooth and into the retentive undercut. Sticky wax is placed to secure the wire.



**Figures 5.2.25a and b.** The left illustration shows the RPD processed and finished. The original lingual contours have been restored and the wrought wire is not visible in the acrylic resin denture base. The right illustration shows the wrought wire adapted to the abutment tooth.

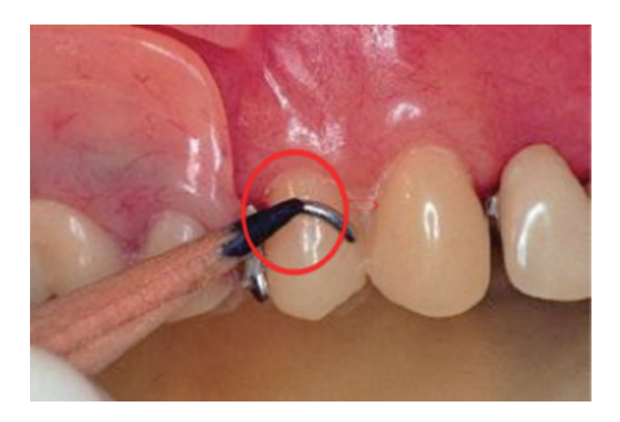


**Figure 5.2.26.** In this photograph, a pencil mark (circled) is made where the retentive wrought wire clasp is no longer in contact with the abutment tooth. The clasp may be readapted to the tooth using pliers.

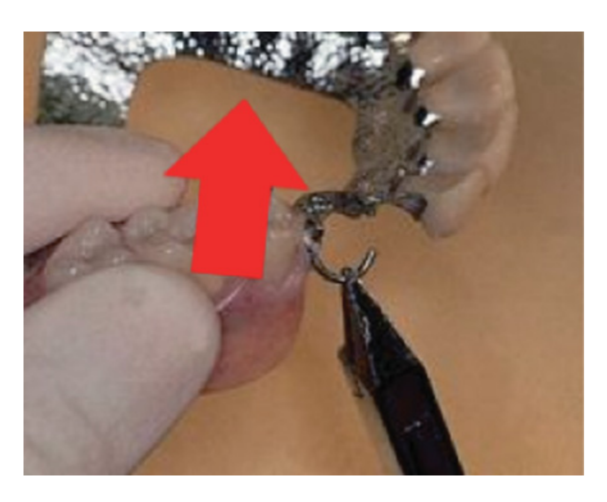


**Figure 5.2.27.** The curved surface of the pliers is toward the tooth side of the wrought wire clasp. It is held parallel to the long axis of the abutment tooth and at the point where the clasp lost contact with the tooth. The pliers are held stationary while the RPD is rotated slightly away from the operator. The RPD should be seated and inspected for adaptation. Change should be made in small increments until tooth contact at the retentive tip is made.

possible. Even fractured major connectors may be repaired. Additionally, fractured abutment teeth or other teeth in contact and in support of the RPD can be restored under an existing RPD. However, each of these procedures is complex and often time-consuming. One should carefully consider the value of attempting such repairs and modifications. It is important to understand and evaluate the conditions that led to the need for the repair. It is often more prudent to correct the conditions and remake the RPD than to repair a prosthesis of marginal use and function. It is beyond the scope of this discussion to elaborate on these procedures. However, there are many excellent publications that describe these advanced clinical and laboratory procedures in depth.

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# 6 Alternative Removable Partial Dentures

## 6.1 Acrylic resin RPDs

There are various indications for prescribing the use of a removable partial denture made entirely of a resin material to include materials that are flexible and intended to fit into tooth and soft-tissue undercuts. An all-acrylic removable partial denture is used for a defined, limited period of time and referred to as an interim prosthesis. The designation of interim versus transitional refers to the clinical scenario where the interim prosthesis will eventually be replaced by a definitive prosthesis, such as one used after an immediate extraction in which a patient requires stabilization and function during the healing phase of therapy. A transitional prosthesis is used when it is anticipated that a patient will continue to lose additional teeth, which can be replaced in the existing transitional prosthesis. The resin removable partial denture also is designed to restore appearance until a definitive prosthesis can be fabricated (Figure 6.1.1).

The terms “temporary removable partial denture” and “flipper” are widely used terms among the general public and even within the dental profession and should be discouraged. More descriptive and professional terms are presented and discussed at length based on the function of the prosthesis. Use of professional terms also conveys a sense of value to the patient and reflects the clinician’s capability at providing the highest quality of care possible (Figure 6.1.2). The terms should be distinguishable when conveying specificity of treatment and levels of fees to insurance providers or other third-party entities since one term refers to a prosthesis that requires minimal to no modification and the other term requires modification intermittently throughout a period of time prior to fabrication of a definitive prosthesis; the latter implying additional time for patient care, additional delivery of care, additional dental laboratory support, and hence additional costs involved in providing ideal patient care.

### Defining the prosthesis based on function

The transitional removable partial denture provides the patient with a functional prosthesis as therapy continues, in transition as the patient loses remaining dentition, yet prior to a definitive prosthesis, typically defined as one that incorporates a cast metal framework removable partial denture. The immediate transitional RPD is used when there is a need to provide the patient with a functional prosthesis at the time of tooth extraction (Figures 6.1.3 and 6.1.4).



**Figure 6.1.1.** Interim removable partial denture with anterior prosthetic teeth, teeth nos. 9 and 10.

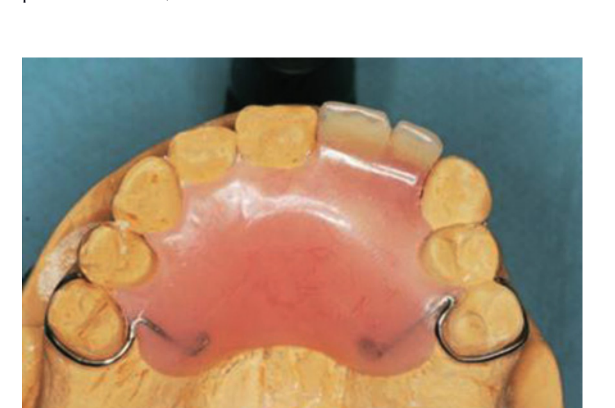


**Figure 6.1.2.** Interim RPD, occlusal view shows wire clasps for retention on bilateral second premolars.



**Figure 6.1.3.** Teeth on the cast have been designated for removal prior to fabrication of the immediate transitional RPD.



**Figure 6.1.4.** The wax-up showing replacement of teeth nos. 23–26 on the immediate transitional RPD.

## Treatment prosthesis

A treatment prosthesis is usually an acrylic resin removable partial denture that is designed as a carrier for materials or medication such as a carrier for treatment of papillary hyperplasia in which it is necessary for the medication to be in contact with the supporting tissues or a fluoride carrier that is used in providing medication as adjunctive treatment. In most instances, this removable partial or complete prosthesis is not the definitive restoration, but provides a valuable service in patient care. To reiterate, the prescribed use of a prosthesis is dependent on the defined type and intended function.

### *Treatment for reestablishment of occlusal vertical dimension*

In restoring a patient to the determined occlusal vertical dimension (OVD), a treatment removable partial denture provides an excellent treatment option for the complex, oral rehabilitation of a patient. The removable prosthesis serves as a diagnostic aid to help determine if a patient can accommodate a change in OVD. This is a reversible option during the comprehensive treatment process since the patient is afforded time to determine initial acceptance and/or feasibility of continuing with a treatment plan, as well as

to determine whether or not he or she can accommodate functionally a prescribed occlusal vertical dimension based on his or her particular diagnosis (Figures 6.1.5 and 6.1.6).

The philosophy of prescribing use of a removable prosthesis in this situation is based on providing a reversible, non-invasive option for the patient such that if the proposed physiologic change is found to be intolerable, the patient can return to his or her pre-existing occlusion since no tooth alterations nor preparations were completed to accommodate the removable prosthesis (Figure 6.1.7). In the situation where the patient and clinician proceed with irreversible procedures such as multiple fixed prosthodontic restorations, segments of the resin prosthesis can be removed to accommodate fixed restorations as completed.



**Figure 6.1.5.** Frontal view of a patient in which an interim RPD will be utilized to help establish the occlusal vertical dimension.



**Figure 6.1.6.** Anterior overlays are incorporated into the RPD design that fit over the remaining natural teeth.



**Figure 6.1.7.** The use of an interim RPD can provide a reversible, non-invasive diagnostic restoration of occlusal vertical dimension.

### *Treatment for temporomandibular disorders*

Treatment for temporomandibular disorders (TMDs) may involve a number of treatment modalities, one of which can include prescribing an occlusal device that can be designed as a removable prosthesis. Use of an occlusal device, commonly referred to as splint therapy, in the treatment of TMD may or may not have teeth incorporated as part of the prosthesis. As with the previously described treatment prosthesis, the occlusal vertical dimension may need to be reestablished based on the proposed change.

Use of a treatment prosthesis provides versatility by allowing the addition of artificial teeth and modification of the resin borders and occlusion. After evidence of symptomatic relief for a sufficient period of time, a definitive removable partial denture would be fabricated. During examination, if it is determined that a patient's soft tissues are not deemed healthy, erythematous inflamed soft tissues can be treated with a

number of different methods. Tissue treatment material can be added to the RPD as a carrier in treatment of abused soft tissues as long as the denture base portion of the RPD covers the site requiring treatment. In a different clinical example, the use of a surgical guide, typically used in a well-defined clinical situation, can also be made to include prosthetic teeth and serve the function as a transitional removable partial denture.

## Definitive acrylic resin prosthesis

An acrylic resin removable partial denture can be prescribed as the definitive prosthesis. The clinical scenarios for use of an acrylic resin RPD include patient situations where there is severe periodontal disease and the remaining natural teeth lack adequate bone support. Use of a conventional removable partial denture is not possible and the resin prosthesis can be used for intermediate- or long-term treatment. Rests and associated rest seats should be incorporated in the design of all RPDs since the rest is one of the key design elements that prevents the prosthesis from over-seating in an occlusogingival direction. If the doctor fails to design and prescribe key elements in an RPD, the intraoral consequences can be irreversible soft-tissue damage, such as stripping of healthy periodontal soft-tissue structures on abutment teeth (Figure 6.1.8).

New dental technologies have created a more "comfortable," pliable, nonrigid material that is used for acrylic resin RPDs. The material becomes more pliable when in the intraoral cavity and the flexibility allows the prosthesis to fit into hard- and soft-tissue undercuts. Many patients state satisfaction with this type of prosthesis, but if proper home care and wearing instructions are not followed, the flexible RPDs can create more damage to tissues than a properly designed acrylic RPD. The same fundamental principles should be incorporated such as vertical stops to prevent over-seating of the prosthesis (Figures 6.1.9 through 6.1.13).



**Figure 6.1.8.** Definitive acrylic resin RPD shows metal rests and clasps to help prevent the prosthesis from over-seating intraorally and prevent stripping of gingival tissues surrounding supporting teeth.



**Figure 6.1.9.** Frontal view of a patient with a maxillary complete denture and a mandibular flexible, all-resin RPD. In this instance, the mandibular resin RPD was designated as the definitive RPD for the patient.

### *Financial limitations*

Financial limitations are of concern for many patients whether or not insurance is available and/or affordable to them; financial constraints are a major factor when determining the best possible care for a patient. Another factor can also be the economics of appropriate dental laboratory support and if there is access to higher cost equipment such as casting machines for RPD metal frame materials.



**Figure 6.1.10.** On closer examination, the flexible resin RPD offers an excellent, esthetic result and fits into hard- and soft-tissue undercuts. Note the change in the occlusal plane between the natural dentition and the prosthetics dentition, between teeth nos. 22 and 23, indicating over-seating of the RPD, which over time could lead to tissue stripping.



**Figure 6.1.11.** After removal of the flexible, all-acrylic resin RPD, teeth nos. 23 through 27 remain and appear to be in fair condition.



**Figure 6.1.12.** Tooth no. 27 shows plaque accumulation and gingival tissues that are erythematous and inflamed; also note the frenum attachment close to the free gingival margin.



**Figure 6.1.13.** Tooth no. 23 shows plaque accumulation and gingival tissues that are erythematous and inflamed; also note the lack of attached mucosa between the free gingival margin and the transition to alveolar mucosa.

## Fabrication of an acrylic resin RPD

Once it is determined that an acrylic resin removable partial denture will be prescribed for a patient, the clinical procedures followed represent a sequence of steps that must be accomplished to fabricate a well-fitting prosthesis.

1. Intraoral examination: Complete clinical examination and radiographic evaluations are necessary prior to the fabrication of the removable partial denture to determine hard- and soft-tissue support and diagnosis of the intraoral condition.
2. Diagnostic casts: Diagnostic casts are important in a comprehensive evaluation of a patient and can be made using irreversible hydrocolloid impression material. The diagnostic casts as part of the patient record are representative of the pre-existing condition. An additional cast should be made as the master cast the dental laboratory technician will use to fabricate the prosthesis and eventually sacrifice if divesting procedures present the need to preserve the prosthesis over the preservation of the master cast.

3. RPD design: Although the acrylic resin RPD design is simpler than that required for an RPD with a metal framework, it is equally as important for the laboratory technician. Philosophically, the design and prescription are the responsibility of the dentist in order to develop the most appropriate design for any prosthesis. Many times, the dentist may consult with the dental laboratory technician regarding materials and design limitations; together, the dentist and technician can work through the design process to get the best possible result for the patient.
4. Prosthesis evaluation: Upon receiving the completed RPD from the dental laboratory, the dentist must evaluate the completed prosthesis related to the prescribed design and the quality in regards to fit, finish, and polish. Each prosthesis should be inspected under magnification to identify any nodules or sharp areas that would be uncomfortable or interfere with seating of the prosthesis intraorally.
5. Intraoral adjustment: After initial inspection of the prosthesis received from the dental laboratory, the use of a disclosing medium can help identify areas that prevent full seating of the intaglio surface to the hard- and soft-tissue support. Various media are available, but a commonly used material is a pressure indicator paste (PIP). The PIP can provide a visual cue in finding pressure or rubbing areas that can be related to the soft-tissue spots, as the specific area is represented by a resin show-through with use of PIP. Disclosing wax can be used on borders for the same purpose and does not wipe off as readily as PIP.
6. Occlusal adjustment: The patient's occlusion should be evaluated and adjusted using articulating materials to mark areas requiring refinement. Centric occlusal contacts in maximum intercuspation should be evenly distributed and of the same intensity as contacts between opposing natural teeth; in most instances, excursive contacts representing working and nonworking interferences are eliminated on the prosthesis.
7. Oral hygiene maintenance and patient education: A preventive dental plan and patient education on dental care, as well as care of the prosthesis, are valuable services as part of comprehensive patient care.
8. Postinsertion care and long-term maintenance: This is one of the most important services and often the least emphasized area of comprehensive care of the patient. Patients should be evaluated within 24 hours after placement of the prosthesis to ensure fit on the intaglio surface and to ensure the prosthesis is comfortable and functional for the patient.

## *Dental laboratory support*

Although the primary scope of this text is to serve as a guide for the clinical practitioner, dental laboratory procedures are included for completeness and can be accomplished by the dentist or staff in the dental office when prescribing an acrylic prosthesis.

1. RPD design: The design of an acrylic RPD can include the use of direct retainers or clasps such as wrought wire or cast wire adaptation to supporting natural teeth or the use of ball clasps, which serve technically as retentive retainers and, when positioned over the occlusal surfaces of natural teeth, help prevent vertical displacement in similar fashion to rests. Clasp designs utilized in acrylic resin RPDs may differ from conventional removable partial dentures in that the use of a type of wire clasp is dependent on the dental laboratory technician's skill at adaptation of the wire to the natural tooth abutment. When considering the flexibility of the wire clasps, the adaptation is limited severely in function considering a semi-rigid prosthesis, which does not include a rigid metal framework. The flexibility of wire clasps provides for engagement into natural tooth undercuts; with functional use and daily removal/insertion of the prosthe-



**Figure 6.1.14.** The stone teeth are removed from the cast to the gingival levels prior to wax-up of the RPD.



**Figure 6.1.15.** The tooth removal from the master cast has been completed.

sis, the retention diminishes over time as compared to the rigidity accomplished with a cast clasp in a conventional metal framework RPD.

2. Removal of stone teeth: This is only necessary if one is constructing an immediate transitional removable partial denture (Figure 6.1.14).
3. Extraction site preparation: The master cast may require adjustment in order to reflect a planned tooth extraction as required primarily for an immediate transitional RPD. The site preparation on the master cast is an important step to ensure good adaptation of the final prosthesis (Figure 6.1.15).
4. Prosthetic tooth selection: Selection of the correct size, shade, shape, and contour of the prosthetic teeth is important in achieving excellent esthetics for the patient. The assumption that the transitional RPD is used for a finite period of time should in no way imply less importance nor less value to the patient. The patient should be able to function with the prosthesis and maintain an acceptable appearance. In some instances, tooth selection is delegated to a novice technician to simply "fill the space," versus the dentist prescribing the appropriate shade and mold form. In this manner, a poor prosthesis may well be defined as poor esthetics when there is a discrepancy between the natural tooth size as compared to the adjacent prosthetic tooth.

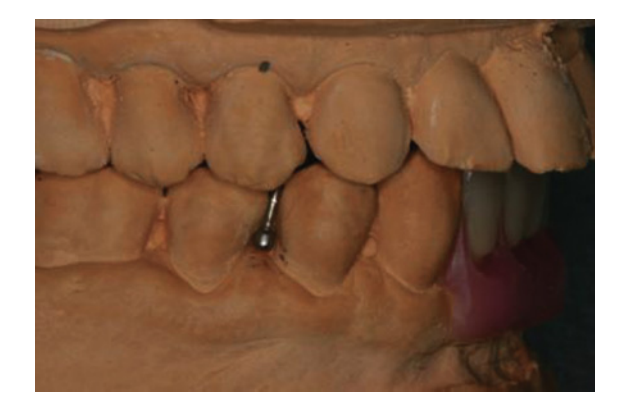


**Figure 6.1.16.** Ball clasp retention can be incorporated into the interim RPD to serve as a vertical stop and to aid in retention of the prosthesis.

5. Customization of prosthetic teeth: It is necessary on a frequent basis to recontour prosthetic teeth to improve the appearance and create similar shapes and contours comparable to the remaining natural teeth. Recontouring may also be needed to fit the prepared site versus selection of too small or too narrow a prosthetic tooth.
6. Clasp selection: Wrought wires or ball clasp of small gauge usually are used for direct retention of the prosthesis on remaining natural teeth (Figure 6.1.16).



**Figure 6.1.17.** The laboratory technician blocks out undercut areas along the lingual surfaces prior to processing acrylic resin.



**Figure 6.1.18.** A pressure pot can be used with a chemical-cure resin to reduce the incidence of porosity in the interim prosthesis made of resin only.

7. Cast blockout: The master cast is blocked out on specific soft- and hard-tissue undercuts to prevent the acrylic resin from locking into undercuts and complicating the insertion of the prosthesis (Figure 6.1.17).
8. Processing resin: Newer materials are available for in-office use to allow staff support in fabrication of an all-resin prosthesis and to remove the barrier for using conventional techniques. A newer material and associated equipment (Dentsply Eclipse, Dentsply Caulk, York, PA) create relatively short turnaround times when providing a prosthesis needed for patient care. Conventional laboratory techniques can be utilized, such as acrylic resin that may be cured as a chemical cure and set in a pressure pot or heat cured in a flask using complete boil-out and a traditional heat-curing process (Figure 6.1.18).
9. Laboratory remount: The laboratory remount procedure is often overlooked, but by remounting the cast with the prosthesis as processed and correcting for laboratory errors, the laboratory remount procedure will help reduce chair time for the dentist.
10. Finishing the prosthesis: The acrylic resin material should be finished and polished methodically to provide a quality prosthesis. The laboratory procedures used to finish and polish the prosthesis result in a smooth surface and high luster for the patient (Figure 6.1.19).



**Figure 6.1.19.** The completed acrylic resin removable partial denture is shown.

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## 6.2 Attachments for RPDs

### Introduction

Attachments were developed after the turn of the twentieth century. Boitel reviewed this development beginning in 1915 when there were a few T-shaped and bar attachments. Terrell gives credit to Herman Chayes and B.B. McCollum for a major development in attachments and refers to them as "practice builders" and not as replacements for conventional removable partial dentures (Figure 6.2.1).



**Figure 6.2.1.** Intracoronal attachments incorporated into the castings with the RPD framework seated in position; intracoronal attachments eliminate the need for clasp assemblies.

Terms that describe attachments include precision and semiprecision, resilient and rigid, clips and snaps, key and keyway, matrix and patrix, and male and female. Although the terms male and female are popular, the terminology of matrix and patrix is preferred.

When considering fabrication of a removable partial denture with attachments, accuracy and precision are as important as when constructing any removable partial denture. For a metal removable partial denture that includes major connectors, minor connectors, rests, and direct retainers incorporated into a framework, the prosthesis must be well made to ensure a precise fit intraorally. Various types of attachments for use in removable partial dentures are available. The four categories of attachments include intracoronal attachments, extracoronal attachments, overdenture attachments, and bar-type attachments; each offers unique indications and advantages over the other types. However, there are also specific challenges and disadvantages in the use of each type of attachment.

## *Intracoronal attachments*

Many manufacturers offer both cast metal attachments and components made of plastic patterns for custom fabrication. Intracoronal attachments are made with a key (patrix) and keyway (matrix) mechanism, typically manufactured such that the keyway or matrix fits within the contours of a crown and the key or patrix is a part of the removable partial denture framework (Figures 6.2.2 and 6.2.3). The patrix engages the vertical walls built within the contours of the crown and resists dislodgement by a torsional resistance of the metal. Intracoronal attachments may include locking mechanisms and frictional or spring retention. Another variation of an intracoronal attachment consists of a spring and plunger mechanism within the attachment in the removable partial denture and a depression into the normal contours of the interproximal surface on the abutment tooth (Figures 6.2.4 through 6.2.12).

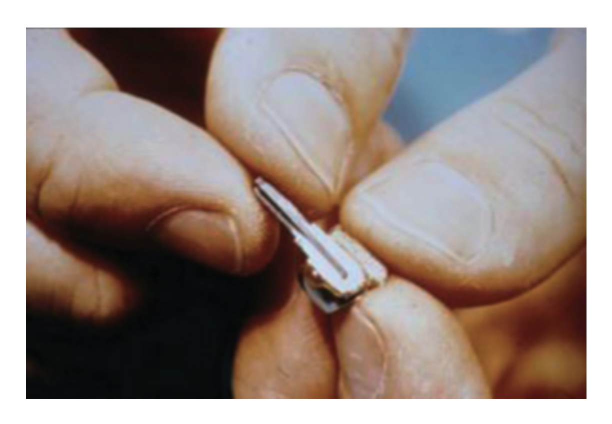


**Figure 6.2.2.** Patrix sliding into matrix of an abutment crown.

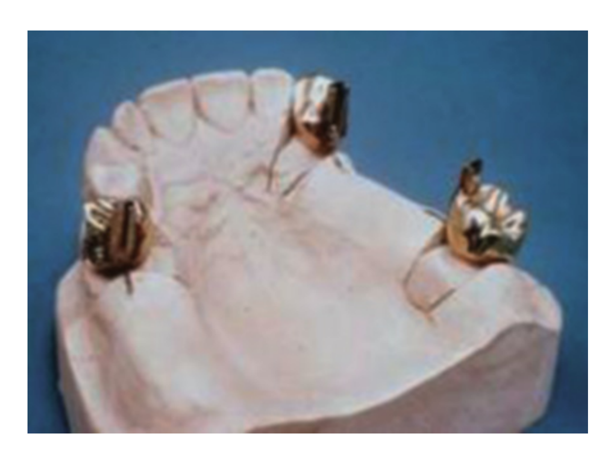


**Figure 6.2.3.** Matrix-patrix mechanisms of intracoronal attachments are shown in abutment crowns.

### Indications

Intracoronal attachments can help obtain esthetic results when used in lieu of traditional

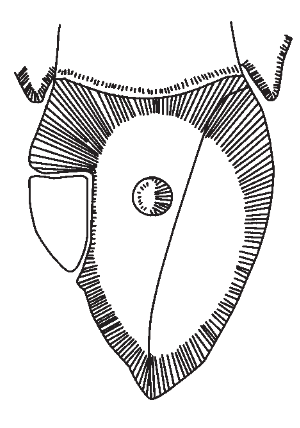


**Figure 6.2.4.** The depression in the proximal surface of the abutment tooth is shown in this diagram. The depression is seen as a uniform, circular depression.

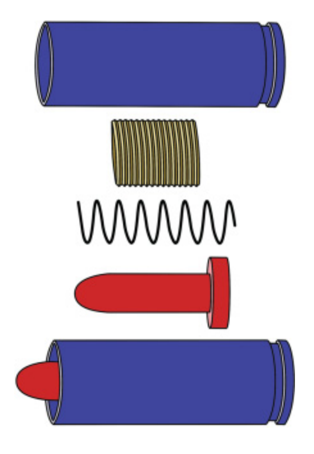


**Figure 6.2.5.** Plunger mechanism (patrix) of the attachment (top three diagrams) that will be incorporated into the removable partial denture framework. The assembled mechanism is shown at the bottom.



**Figure 6.2.6.** Abutment wax pattern is shown with the circular depression waxed into the proximal (distal) surface of the crown.

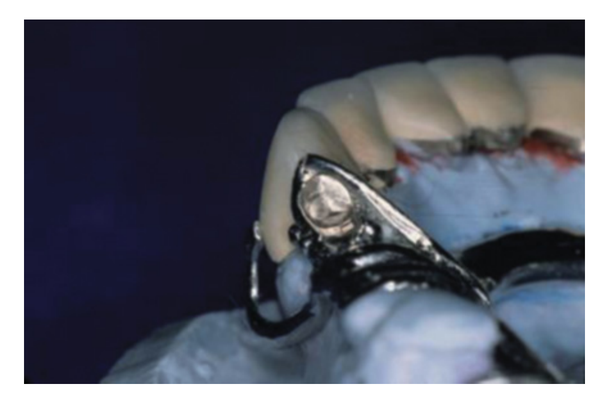


**Figure 6.2.9.** The plunger mechanism is distal to tooth no. 6, incorporated in the RPD framework.

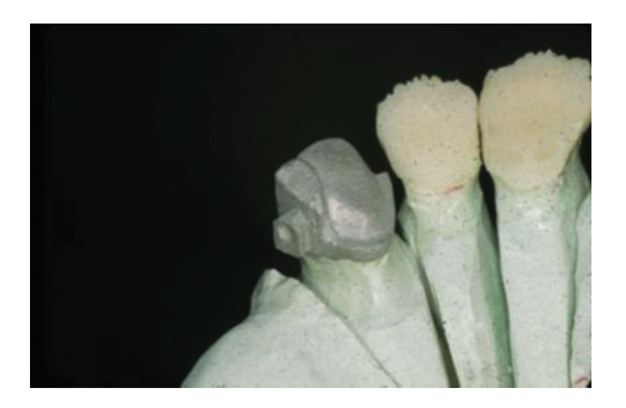


**Figure 6.2.7.** The casting shows a proximal depression that was waxed into the surface.



**Figure 6.2.10.** Occlusal view of the RPD framework; the plunger mechanism is distal to tooth no. 6 and occupies a significant amount of space mesiodistally. Framework with plunger mechanism attached.



**Figure 6.2.8.** The metal ceramic crown has been completed and the view shows the plunger mechanism placed in position as it would be within the RPD framework.



**Figure 6.2.11.** Tissue surface (intaglio) view of the completed RPD.

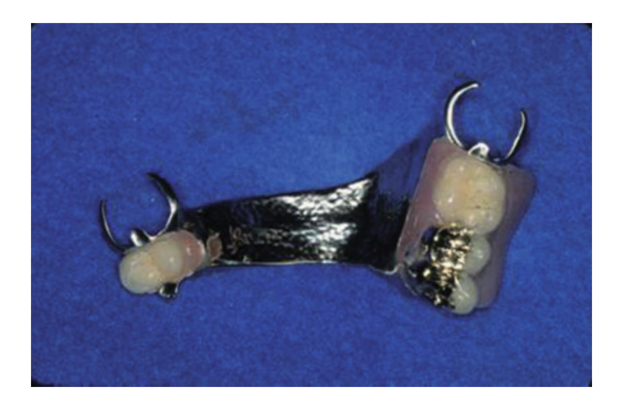


**Figure 6.2.12.** Completed RPD with attachment incorporated.

clasp assembly retention. An intracoronal attachment is indicated primarily for tooth-supported situations to provide esthetics and cross-arch stabilization.

## Advantages

In addition to improving esthetic outcomes, intracoronal attachments provide improved leverage management. The attachment acts as a deep internal rest seat that transfers vertical forces closer to the axis of rotation on the abutment tooth. Intracoronal attachments also have a rigid connection that does not require indirect retention.

## Disadvantages

The intracoronal attachment requires extensive preparation of an abutment tooth in order to obtain space for the matrix mechanism; aggressive crown preparation into the appropriate proximal surface allows creating a casting without creating an overcontoured crown, which could compromise periodontal health. This is particularly true on natural teeth that are narrow faciolingually, and also for teeth that have short clinical crowns. Based on this disadvantage, the large pulp chambers present in teeth of younger individuals present as a contraindication for use of intracoronal attachments (Figures 6.2.13 and 6.2.14).

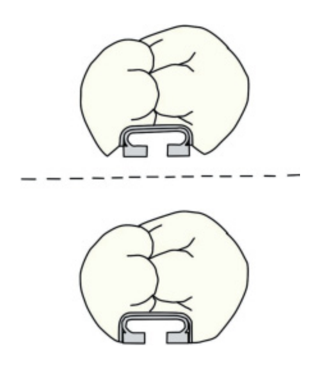


**Figure 6.2.13.** Diagram shows relative space needed to accommodate the matrix component of an intracoronal attachment within the confines of the extracoronal contours of a crown.



**Figure 6.2.14.** Palatal view of an intracoronal attachment in an abutment crown that requires space for one of the attachment components.

A major problem with intracoronal attachments other than being difficult to repair is that the key or patrix wears over time, resulting in loss of retention. Patients also need to demonstrate good manual dexterity, since this type of prosthesis can be difficult to place and remove from the mouth.

## Contraindications

Use of attachments is contraindicated in most mandibular distal-extension removable partial dentures (Kennedy Classifications I or II), especially when a type of stress director is not incorporated as part of the attachment. Functional movement of the prosthesis can generate stresses

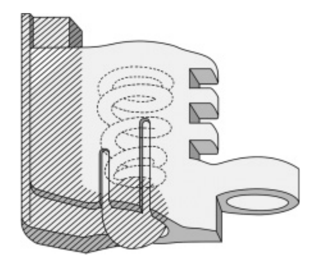


**Figure 6.2.15.** Spring-loaded extracoronal attachment with a vertical bar with ball incorporated into the distal surface of a crown as the patrix component, shaded gray. The matrix component is shown with an internal spring mechanism in housing that will be incorporated into the removable partial denture framework.

on the abutment tooth, and if not managed or designed well, can be excessive and result in loss of supporting bone.

## *Extracoronal attachments*

### Indications

Extracoronal attachments are equally as esthetic as intracoronal attachments, but unlike intracoronal attachments, they have the ability to provide more resilience as a stress director if this action is desired for a particular clinical situation (Figure 6.2.15).

### Advantages

Use of extracoronal attachments can be perceived as easier for use as compared to intracoronal attachments. The extracoronal attachments are indicated frequently for anterior prostheses in younger patients who have large dental pulp chambers (Figures 6.2.16 and 6.2.17).

### Disadvantages

Extracoronal attachments, by design, appear bulky outside the physiologic contours of the crown since more space is required within the removable partial denture. Many types have springs and component parts that can break or wear, requiring additional adjustment, repair, or replacement (Figure 6.2.18).



**Figure 6.2.16.** Extracoronal ring (matrix) extends proximally.



**Figure 6.2.17.** Diagram shows extracoronal attachment component that extends into the proximal area and requires space.

## *Overdenture attachments*

### Indications

As the title indicates, these types of attachments are used on overdenture abutments, either abutments that are natural teeth or dental implants. They are also referred to as stud-type attachments, include some of the lowest profile attachments in an occlusogingival dimension, and provide a stress-directing effect (Figure 6.2.19). The modes of attachment vary greatly among the various types and provide unique versatility. The individual types of attachments may vary as do the advantages and disadvantages of each type of overdenture attachment (Figure 6.2.20).

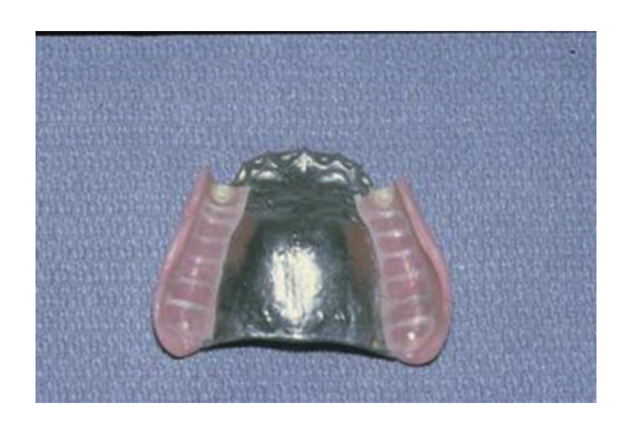


Figure 6.2.18. Attachment component must be accommodated within the RPD, which weakens this area of the prosthesis.

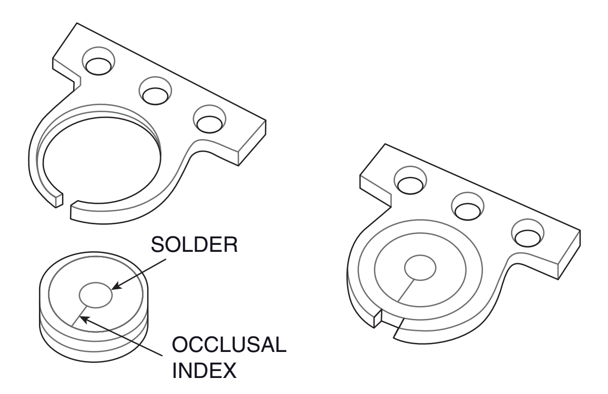



Figure 6.2.19. The Rotherman overdenture attachment is one of the lowest profile attachments, meaning it requires less occlusogingival space to accommodate in a prosthesis.

## Advantages

In addition to versatility, advantages include tolerance when used with misaligned abutments, ease of maintenance, ease of adjustment, and repair. There is decreased leverage since the attachment mechanism closely approximates the axis of rotation when compared to the axis of rotation using the intracoronal attachments. The individual attachments selected should be evaluated and prescribed to maximize advantages on an individualized patient situation (Figures 6.2.21 through 6.2.23).

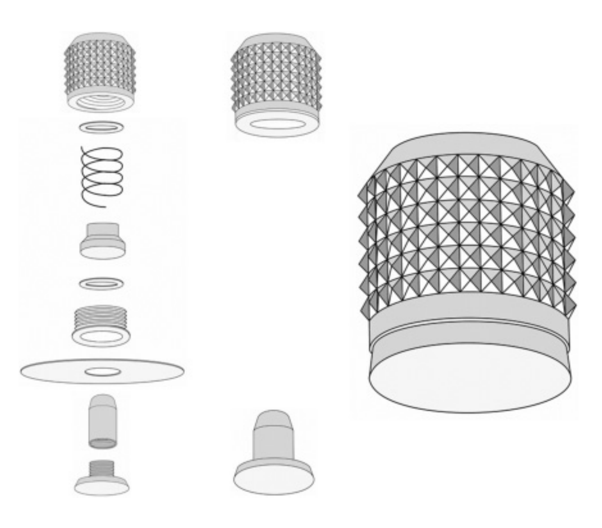


Figure 6.2.20. Design variability among attachment mechanisms provides versatility and choice in selection.



Figure 6.2.21. Ball component (patrix) for an O-ring attachment was cast to the overdenture abutment coping.

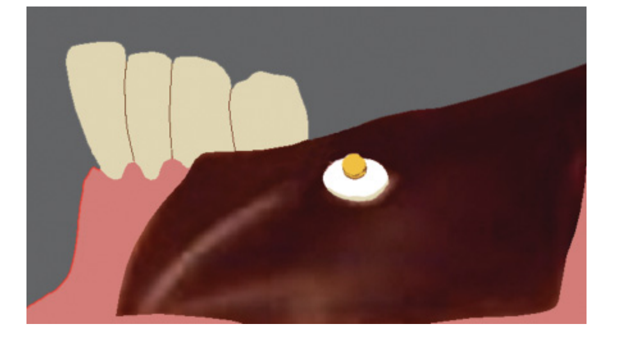


Figure 6.2.22. The O-ring and housing (matrix) have been placed on the ball attachment/abutment; a piece of rubber dam is inserted between the components as a blockout to prevent locking the mechanism during the clinical pickup procedure.



**Figure 6.2.23.** The view of the intaglio surface shows the O-ring incorporated into the removable partial denture.

### Disadvantages

Clinical problems can occur, including adverse effects on prosthesis stability by the tilting effect or tipping potential, additional wear of mechanical components over time, design complexity for the attachment, available space from an occlusogingival perspective and space within the physiologic contours of the prosthesis, and additional expense incurred by the patient beyond the cost of the prosthesis.

## *Bar-type attachments*

Most bar and clip attachments involve a type of mechanism in the design of the attachment (Figure 6.2.24). The differences in the mechanism are based on design to include clip retention, rotation around the bar, frictional retention of a superstructure, and combinations of clip and other types of attachments. Bar attachments can be cast, machine manufactured, milled, or refined using electrodischarge machining.

### Advantages

A bar attachment provides advantages such as rigid splinting of natural teeth and cross-arch stabilization. Indications include clinical scenarios in which there is considerable bone loss around the remaining abutment teeth (Figure 6.2.25). Other attachments may be used in conjunction with bars and/or in combination with osseointegrated implants for a combination fixed-removable prosthesis.



**Figure 6.2.24.** Metal clip (matrix) snaps onto a bar.



**Figure 6.2.25.** Cross-arch stabilization is shown by use of a bar cast to abutment crowns on the two remaining mandibular canines.

### Disadvantages

The main problem with a bar attachment is restriction of use based on intraoral space limitations, interarch space, and interocclusal space, defined limits associated with ideal contours of a prosthesis. Additional laboratory procedures may be needed to fabricate a bar attachment

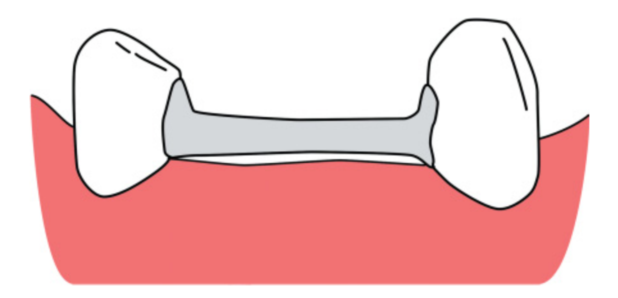


**Figure 6.2.26.** Minimal space gingivally exists between bar and tissue to reduce leverage forces.

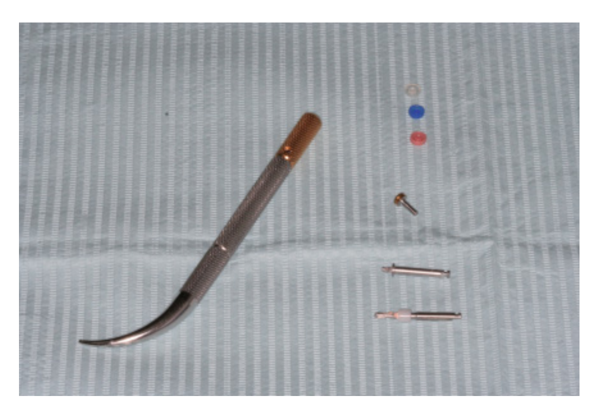


**Figure 6.2.27.** Custom components and instrumentation for use clinically and specifically for a type of an attachment.

such as soldering procedures, which can complicate the patient treatment (Figure 6.2.26). Plaque control is more difficult with a bar as compared to freestanding attachments, and the patient should have thorough home care instructions and appointments for oral hygiene maintenance procedures for long-term monitoring.

## Fabrication of an overdenture attachment for a removable partial denture

As stated previously, there are different types of attachments, each with specific indications and advantages. Some require complicated and technique-sensitive dental laboratory procedures, while others are simple but involve meticulous attention to detail. It is not within the scope of this chapter to review the nuances of laboratory procedures among attachments; rather a technique that is used in a clinical setting is presented using one type of overdenture attachment.

Clinical Procedures

1. Examine the mouth. Complete clinical and radiographic examinations are necessary prior to prescribing the use of an attachment for a removable partial denture. A radiographic examination is valuable in viewing aspects of the abutment root and supporting structures. The clinical examination provides the evaluation of the remaining teeth and hard and soft tissues.



**Figure 6.2.28.** Dental materials, supplies, and instrumentation should be organized to ensure an efficient appointment for the practitioner and patient.

2. Obtain the appropriate instrumentation and components. Appropriate instruments must be identified while attachment-specific components should be selected and ordered (Figure 6.2.27).
3. Prepare for the clinical procedure. Many dental materials and supplies for these procedures are readily available in most dental offices (Figure 6.2.28).
4. Prepare the post space and cement the post manufactured with the patrix portion of the attachment. The patrix may also be waxed and cast onto a coping for a natural tooth, may be screwed into an implant, or may



**Figure 6.2.29.** The Locator™ matrix component can be cemented directly into the post space of a natural tooth abutment, eliminating the need for a casting.

even be manufactured as part of the implant (Figure 6.2.29).

5. Attach the nylon matrix to the patrix. Many attachment systems now include a metal housing as part of the system for ease of replacement. In the Locator™ system, the processing nylon matrix is black with essentially no retention. The terminology can be confusing, as the manufacturer of Locator™ calls a "male" or patrix what is referred to typically as a matrix. It may also be necessary to block out undercuts around the tooth or attachment using a wax or other product such as Oraseal™ (Ultradent, Salt Lake City, UT) (Figure 6.2.30).
6. Prepare the site for the matrix within the RPD. This is accomplished in many different ways, as some prefer a small vent hole and others prefer direct access through a larger hole in the prosthesis. In any case sufficient space must be available to accommodate the attachment.
7. Mix the autopolymerizing acrylic resin. This may be done by using either a salt and pepper technique with the RPD seated or by mixing the chemical-cured resin and placing the "free-flowing mix" into the prepared site within the RPD prior to seating the prosthesis (Figures 6.2.31 and 6.2.32).
8. Trim, finish, and polish the RPD. Excess resin is trimmed. The resin that extruded through the vent hole is removed and the



**Figure 6.2.30.** Housing and blockout spacer position on the natural tooth abutment.



**Figure 6.2.31.** Autopolymerizing resin is mixed and prepared for the clinical pickup procedure.

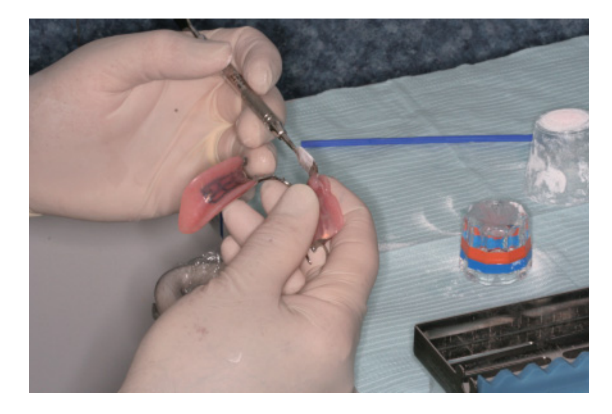


**Figure 6.2.32.** Resin is placed in the RPD.



**Figure 6.2.33.** RPD removed from the mouth.

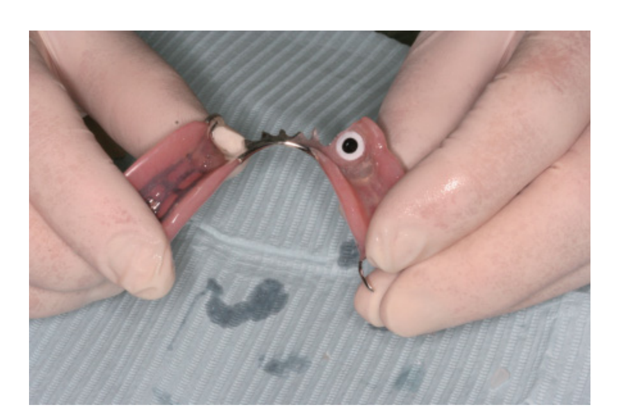


**Figure 6.2.34.** Intaglio view shows the nylon spacer incorporated into the RPD.

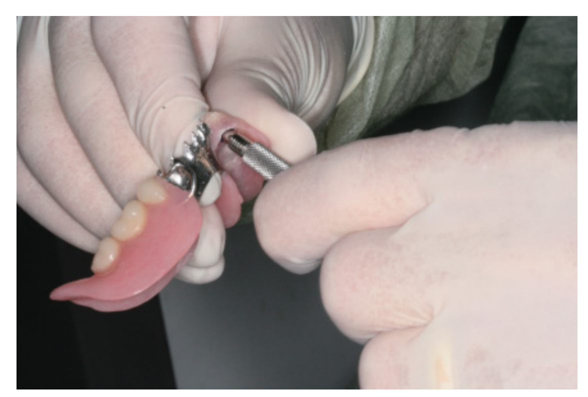


**Figure 6.2.35.** Excess resin is trimmed from the prosthesis.

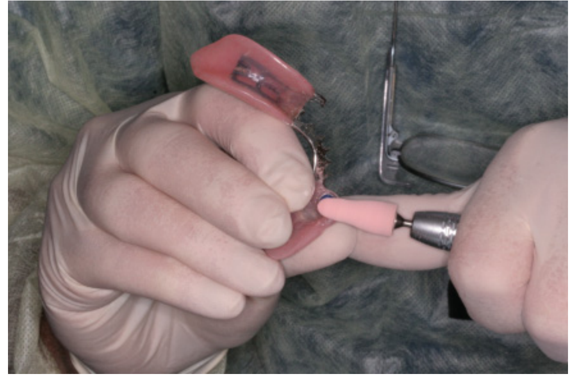


**Figure 6.2.36.** Finish and polish the resin prior to insertion and delivery.

removable partial denture is polished (Figures 6.2.33 through 6.2.36).

9. Replace the black nylon processing matrix with a blue nylon matrix. The blue nylon matrix has the least amount of retention as described by the manufacturer. As the patient acclimates to the new attachment mechanism, subsequent nylon matrixes can be replaced with more retentive components (Figure 6.2.37).
10. Adjust the intaglio (tissue) surface. The tissue surface should be adjusted and relieved as needed using pressure indicator paste or a disclosing medium to identify areas that are potential sources of irritation for the patient.



**Figure 6.2.37.** The processing matrix is removed and replaced with the definite attachment into the removable partial denture.



**Figure 6.2.38.** Completed RPD.

11. Adjust the occlusion. The occlusion is checked with occlusal marking paper or ribbon to identify interferences and occlusal centric stops; the appropriate occlusion is established.
12. Review oral hygiene and home care of the RPD. Careful review of home care maintenance and basic insertion-removal techniques should be reviewed with the patient. A patient should be instructed to avoid "biting the RPD into place" in the mouth, as this could create problems with the attachment and unnecessary complications.
13. Postinsertion and maintenance: Patients should be seen within 24 hours after inserting the prosthesis to ensure patient comfort (Figure 6.2.38).

## Summary

Four categories of attachments have been described: intracoronal, extracoronal, overdentures, and bar-type. With the predictable incorporation of osseointegrated implants into treatment planning a patient's needs, the realm of possibilities for removable partial dentures and attachments has increased. In clinical situations where a patient may have presented with too few teeth or poor locations of remaining abutment teeth, the addition of dental implants and various attachments can now be made into an excellent scenario for removable partial dentures. Although predictions based on insured populations may show less need for removable partial dentures, the reality is that with the development of new attachments and improved predictability of adjunctive dental implant placement, there should be an increased demand for alternative uses of adjunctive treatment.

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## 6.3 Dental implants in RPDs

The high success rates of dental implants over the past decades have influenced the treatment planning philosophy of dentists who perform prosthodontic procedures in their practices.

The patient who presents with a partially edentulous arch can be rehabilitated with a removable partial denture prosthesis based on various diagnostic factors. The rationale for prescribing a removable partial denture includes factors that relate to the unfavorable prognosis for prescribing a fixed prosthesis such as the number of natural teeth remaining in the arch, distribution, location, and periodontal support and condition of the teeth.

In some instances when a removable partial denture seems to be the only treatment alternative for tooth replacement in a patient with a partially edentulous arch, the strategic incorporation of dental implants significantly can benefit the biomechanics intraorally. By placing an implant in a specific location in the arch, the fulcrum and leverage forces can be altered and provide additional vertical support. Moreover, the use of implants can redefine the patient's needs, which previously may have been limited to a conventional removable prosthesis, and the patient can now receive a fixed, implant-assisted prosthesis.

The incorporation of implants in removable partial prosthodontics provides many advantages and potential disadvantages (Tables 6.3.1 and 6.3.2). When comparing the advantages and disadvantages, the benefits associated with incorporating implants to assist in the support and stability of the resulting prosthesis can create a better solution. In the treatment of a patient with a partially edentulous arch, the addition of implants can offer treatment alternatives in conjunction with removable prosthodontics, and in most instances, the use of implants will offer an overall better solution.

Dental implants can be used to enhance patient care in clinical scenarios in which placement of an implant improves what would be

**Table 6.3.1.** Advantages with incorporation of implants in the RPD treatment plan.

| |
|---|
| Improved esthetics by the elimination of visible clasp assemblies |
| Ability to change fulcrums in the arch providing more favorable biomechanics |
| Minimizing rotational and lateral forces on direct and indirect abutment teeth |
| Controlled additional vertical support especially significant in partially edentulous patients with distal extensions |
| Provide additional retention and stability to the prosthesis by incorporating an attachment mechanism |
| Simplify prosthesis design and base extension |
| Highly predictable treatment |
| Easy to maintain depending on prosthesis design and attachment system |
| Minimize excessive pressure and trauma to soft tissues and supporting ridge with alteration of the biomechanical forces |

**Table 6.3.2.** Disadvantages of using implants in removable partial prosthodontics.

| |
|---|
| Additional costs for treatment |
| Additional surgical procedures |
| Extended treatment time |
| Involve careful treatment planning and interdisciplinary approach |
| More technique sensitive than a conventional RPD |
| Additional maintenance over time depending on prosthesis design and attachment systems used. |
| Manual dexterity can be challenged in certain patient populations, eg., rheumatoid arthritis, limited mobility |
| Increased costs to overall treatment |

considered originally an unfavorable removable partial denture design. Incorporating implants is a viable, well-researched, and well-documented treatment option in dental practice. In the current environment of dental practice, the practitioner should offer patients the option to incorporate implants into a treatment plan. Incorporation of implants as an adjunctive therapy is a viable and possibly a cost-effective treatment modality for the partially edentulous patient. Placement and positioning of a limited number of implants with no rigid connection between implants and teeth is a valid solution for improving the long-term success in removable partial denture designs that might not otherwise be considered an ideal treatment alternative.

The use of implants to serve as support in the instance of a distal-extension removable partial denture, Kennedy Class I or II, is probably one of the most important applications that a clinician can find for implants in combination with removable partial prosthodontics. In removable prosthodontics, retention is defined as the resistance in the movement of a denture away from its tissue foundation, especially in a vertical direction such that adjunctive procedures can assist in retaining the prosthesis on the tissue foundation and/or abutment teeth. Stability of a prosthesis refers to the resistance of a prosthesis to movement on its tissue foundation, especially to lateral (horizontal) forces as opposed to vertical displacement. Stability is also related to the quality and fit of a prosthesis that permit it to maintain a state of equilibrium in relation to its tissue foundation and/or abutment teeth.

In the Kennedy Class I and Class II clinical scenario, the traditional design of RPDs is limited in biomechanical ability to provide maximum prosthesis stability, to provide retention, and to accommodate ideal occlusal function, and creates challenges when considering the retentive clasp assemblies are often unesthetic. If the clinical situation permits, implants can be placed in the edentulous ridge distal to the most posterior natural tooth abutment in the arch to stabilize the prosthesis and change the location of the fulcrum, minimizing the resultant rotational movement (Figures 6.3.1 through 6.3.12). Significantly less displacement of the implant-supported removable partial denture and decreased pressure on soft tissues are observed when comparing it to a conventional prosthesis of the same design without implants.

The lack of posterior teeth in partially edentulous patients with shortened dental arches can compromise the stability of the patient's remaining dentition for occlusal support. A single implant or multiple posterior implants that serve as support underneath a removable partial



**Figure 6.3.1.** Initial condition of partially edentulous maxilla. Tooth no. 14 has been diagnosed with a vertical root fracture and will be extracted.



**Figure 6.3.3.** Metal ceramic restorations fabricated to meet the design needs for the RPD design, path of insertion, and in support of the design, which includes implants placed in the distal extension edentulous area.

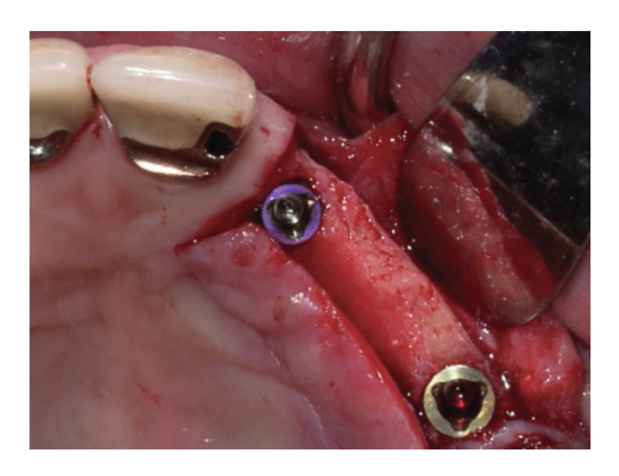


**Figure 6.3.2.** Implants are placed posteriorly adjacent to the distalmost tooth and another implant is placed in the distal extension area.



**Figure 6.3.4.** Occlusal view of the maxillary arch after restoration of the remaining natural teeth, osseointegration of the implants, and soft-tissue healing. Locator attachments (Zest Anchors, Inc., Escondido, CA), the matrix components, were placed and the location and distribution of implants have changed the biomechanical requirements of the RPD design.



**Figure 6.3.5.** The attachment housings (patrix) are placed on the corresponding components and a blockout spacer is placed between the two components, as seen by the white-ring appearance at the gingival margins. The blockout spacers are placed in preparation for intraoral pickup to incorporate the retentive components within the prosthesis.



**Figure 6.3.7.** The frontal view shows the preoperative condition before implants were placed to assist the retention and stability of the definitive removable partial denture.



**Figure 6.3.6.** The cameo view of the RPD shows two vent holes created to allow injection of material utilized for direct pickup of the retentive components of the attachment system. The vent holes allow excess material to escape and ensure optimal seating of the prosthesis.



**Figure 6.3.8.** The frontal view shows completion of the metal ceramic restorations on the maxillary teeth and implant attachments visible in the patient's left maxillary sextant.



**Figure 6.3.9.** The frontal view shows the patient in maximum intercuspation with the completed prosthesis—a removable partial denture—in position.



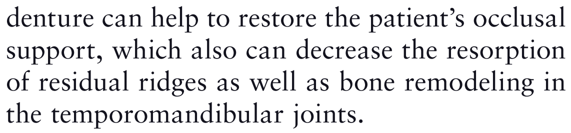
**Figure 6.3.11.** The blockout spacer is positioned over the matrix component onto the gingival area.



**Figure 6.3.10.** The Locator™ attachment, matrix component, is placed into the implant for intraoral direct pickup of the patrix processing component.

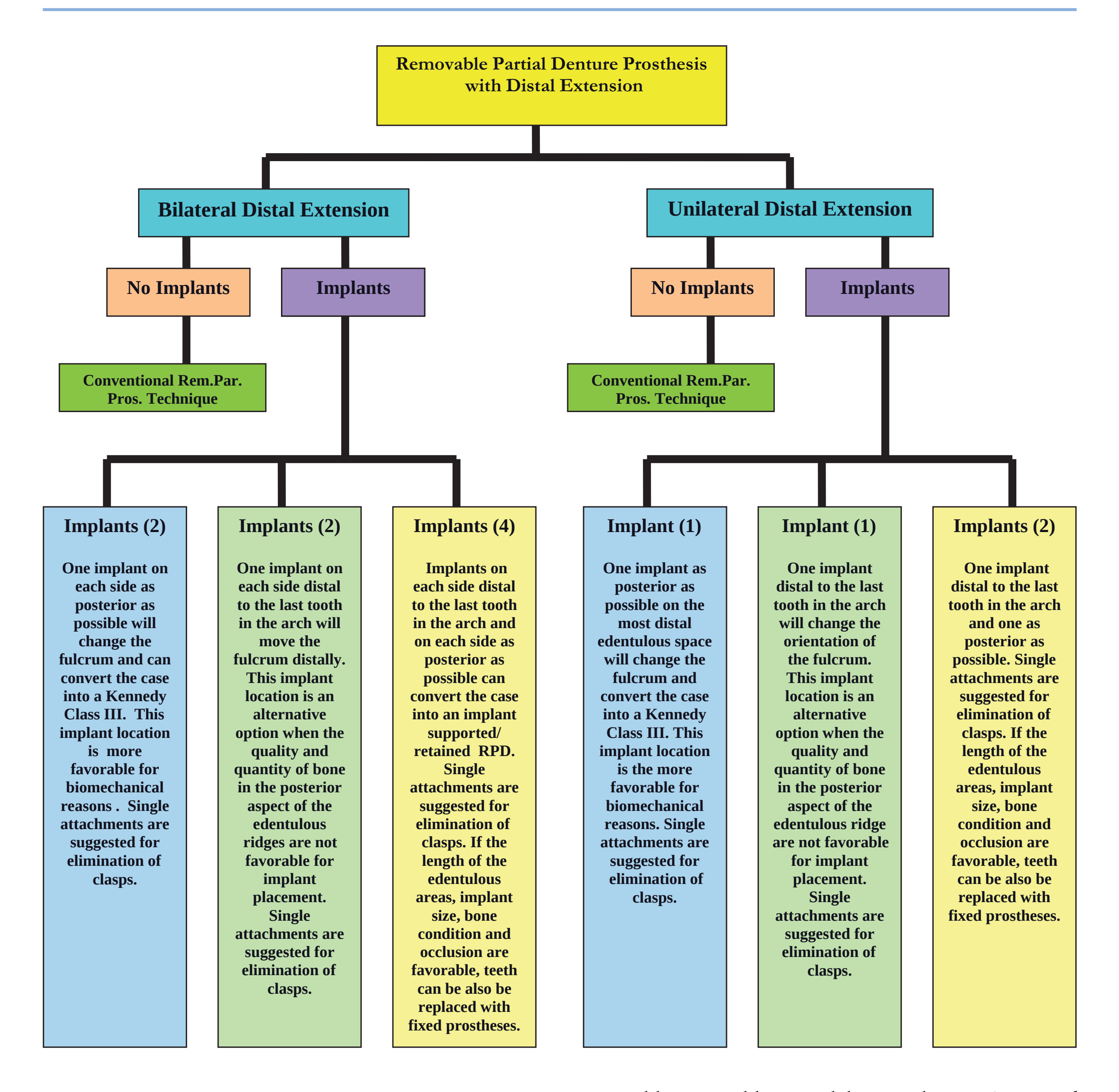


**Figure 6.3.12.** The corresponding patrix housing is seated onto the matrix component and the blockout spacer is visible between the two components.



denture can help to restore the patient's occlusal support, which also can decrease the resorption of residual ridges as well as bone remodeling in the temporomandibular joints.

When using implants in combination with removable partial dentures, the clinician has the ability to control the degree of simplicity or complexity of the design for any patient. Difficult situations often require intricate prosthetic designs and should be managed by the prosthodontist. The use of low-profile, self-aligning implant attachment systems is recommended for many situations. Whenever possible, simplicity in design and predictable use of implant prosthetic components are desired. Professional judgment and overall clinical assessment can be weighed against the capabilities and comfort zone of the general practitioner, especially when considering use of adjunctive implant treatment (see the flow chart as follows).




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## 6.4 Alternative RPD designs

Prosthodontic treatment planning has become a complex process that involves a combination of diagnostic information, patient desires, patient resources, evidence-based outcome data, and a thorough review of treatment alternatives. Prosthodontic treatment options include alternative removable partial denture designs in contrast to conventional extracoronal clasp-retained removable partial dentures. Removable partial overdentures and swing-lock removable partial dentures are two examples of alternative RPD designs.

## Removable partial overdentures

The overdenture concept has been used in complete denture treatment for many years with excellent results. As early as 1856, Ledger published a paper encouraging dentists to leave "stumps" under a complete set of artificial teeth. In 1958, Miller published a manuscript describing a clinical technique where natural tooth crowns were reduced and tooth roots were intentionally maintained under a complete denture. The landmark articles that describe simplified tooth-supported complete overdenture treatment were published in 1969 by Morrow et al. and Lord and Teel. Later textbooks written by Brewer and Morrow described the principles, concepts, and techniques specific to tooth-supported complete overdenture treatment.

Use of natural teeth as overdenture abutments can provide a viable treatment option for partially edentulous patients. The use of a natural tooth as an overdenture abutment helps preserve surrounding alveolar bone, as well as provide support and stability for the removable partial denture. Strategic overdenture abutment teeth locations help minimize movement of a removable partial denture, thereby reducing stresses transferred to remaining natural teeth and the residual ridge.

### *Advantages of removable partial overdentures*

The advantages of removable partial overdenture treatment include

- Mobile natural teeth can be maintained by shortening the clinical crowns of the natural teeth.
- Patient maintains some proprioception from the natural teeth.
- Natural tooth overdenture abutments help to preserve the alveolar bone and lessen the soft-tissue trauma resulting from functional forces generated by the prosthesis.
- Natural tooth overdenture abutments help stabilize record bases during jaw relation records.
- Increased support and stability of the prosthesis.
- Improved biting force and masticatory performance.
- Attachments can be used on natural tooth overdenture abutments for improved removable partial overdenture retention.

### *Disadvantages of removable partial overdentures*

Disadvantages of overdenture treatment are related to prerequisite treatment, which requires additional time, increased cost, and increased demands on the patient's oral hygiene. Disadvantages of removable partial overdenture treatment include

- Increased time and expense due to required periodontal therapy for retained natural teeth.
- Increased time and expense due to required endodontic therapy for retained natural teeth.
- Increased time and expense due to required maintenance procedures for natural tooth overdenture abutments and overdentures.
- Requirement for sufficient interarch space to allow for denture coverage of the natural tooth overdenture abutments.
- Retained natural tooth overdenture abutments may interfere with esthetic denture tooth

placement, especially in the anterior maxillary area.

- Significantly increased demands on the patient's oral hygiene. The failure of natural tooth overdenture abutments is most often related to poor oral hygiene.

## *Indications for removable partial overdentures*

Removable partial overdentures are used to treat partially edentulous patients according to three general categories: posterior edentulous areas, anterior edentulous areas, and interim prostheses.

### Posterior edentulous areas

Tooth- and tissue-supported removable partial dentures (Kennedy Class I, II, and IV removable partial dentures) are designed to counteract leverage-type forces around fulcrums present that can induce stresses on remaining teeth and tissues. The distal-extension removable partial denture has the greatest potential for generating harmful leverage-induced stresses to supporting abutment teeth. Every effort to retain a posterior abutment can help prevent movement of the distal-extension denture base toward the soft tissue (Figure 6.4.1).

A mobile, periodontally involved posterior natural tooth can be treated with endodontic therapy; by reducing the occlusogingival height of the natural tooth and lowering the center of rotation, the mobility of the natural tooth can be decreased. In a similar manner, extruded posterior natural teeth can be treated endodontically and the height of the clinical crown can be decreased with similar results. In extreme clinical situations, a mobile and/or extruded tooth can be treated endodontically, or a tooth can be hemisected to allow use of a posterior natural tooth with furcation involvement as an overdenture abutment.



**Figure 6.4.1.** A mandibular molar is used as a removable partial overdenture abutment to prevent movement of the distal-extension denture base toward the soft tissue.

### Anterior edentulous areas

Vertical overlap of the anterior teeth is usually required to obtain an esthetically pleasing removable partial denture for a partially edentulous patient with an anterior edentulous area. As a result of this vertical overlap of the anterior teeth, lateral and vertical forces are applied to the anterior denture teeth, causing movement of the RPD and increased potential for resorption of the anterior residual ridge. Retention of an overdenture abutment tooth in the anterior edentulous area not only provides support and stability for the removable partial denture but also prevents resorption of alveolar bone (Figures 6.4.2 and 6.4.3).

### Interim prostheses

It is not uncommon for a patient to request an interim removable partial denture for esthetics and/or function during preprosthetic procedures. At times it is difficult to derive the prosthodontic treatment plan because the prognosis of some natural teeth remains in doubt. It is important to evaluate the patient's oral hygiene and/or the response to periodontal and endodontic treatment prior to determining the final treatment plan. Partially edentulous patients can be provided with interim removable partial dentures while endodontic, periodontic, and restorative procedures are completed.



**Figure 6.4.2.** A maxillary central incisor is used as a removable partial overdenture abutment to provide support and stability for the anterior denture base and prevent resorption of alveolar bone.



**Figure 6.4.3.** Vertical overlap of the maxillary anterior denture teeth provides an esthetically acceptable removable partial denture for a partially edentulous patient with an anterior edentulous area.

## *Design considerations for removable partial overdentures*

The fundamentals of RPD design can be applied to design of a removable partial overdenture. However, additional considerations are important to the choice of direct retainer and the design of the denture base for a removable partial overdenture.

The location of an overdenture abutment in a posterior edentulous area helps determine the principal fulcrum line for the removable partial denture. If the denture base does not extend distally to the overdenture abutment, the removable partial denture on that side of the arch can be considered tooth supported, and the direct retainer is selected accordingly. If the denture base extends posteriorly beyond the overdenture abutment, this is similar to a distal-extension scenario, so the retentive clasp arm on the abutment tooth anterior to the overdenture abutment should be designed to minimize forces on the anterior abutment tooth. A combination clasp with a wrought wire retentive arm is the direct retainer of choice for this situation, a conventionally clasped abutment tooth anterior to the overdenture abutment, which functions as the most posterior abutment on that side of the arch (Figure 6.4.4).



**Figure 6.4.4.** Removable partial overdenture framework designed with a combination clasp on the conventionally clasped abutment tooth anterior to the overdenture abutment and the denture base retention minor connector providing space around the overdenture abutment.

The denture base can be designed to contact an overdenture abutment tooth in one of two ways: an attachment can be used that will provide retention for the RPD, or the denture base resin can be in direct contact with the overdenture abutment. In most instances, adequate retention is provided using conventional direct retainers (clasps) and the overdenture abutments are used only for RPD support and stability. When the denture base resin is in contact with the overdenture abutment, the framework is designed to ensure the denture base retention

(latticework) minor connector does not cover the abutment (Figure 6.4.4). The space around the overdenture abutment allows the denture base acrylic resin to be fitted and/or adjusted over the contour of the overdenture abutment.

## *Clinical considerations for removable partial overdentures*

Most of the clinical procedures are the same for a removable partial overdenture as for a conventional removable partial denture. Appropriate preparation of an overdenture abutment tooth is needed since a denture tooth must be placed over the abutment tooth. Without adequate reduction of an overdenture abutment tooth, the denture base resin strength is compromised and an esthetic result is difficult to obtain. Sufficient facial reduction of the overdenture abutment tooth must be made to allow placement of a denture tooth without compromising the esthetic results. The preparation of the overdenture abutment tooth should extend slightly above the free gingival margin. The facial taper of an overdenture abutment from the gingival margin to the center of the tooth should be 25° to 30°. The proximal and lingual tapers of an overdenture abutment should be 10° to 15°.

Contact between the denture base resin and the overdenture abutment tooth can be refined clinically using an autopolymerizing resin. The intaglio (tissue) surface of the denture base around the overdenture abutment is adjusted to ensure adequate bond between the denture base acrylic resin and the autopolymerizing acrylic resin. Create a small vent hole through the lingual surface of the denture base covering the overdenture abutment. Mix tooth-colored autopolymerizing acrylic and place a small amount of autopolymerizing resin in the prepared area on the intaglio surface of the denture base. The RPD is placed in the patient's mouth and the patient is instructed to close into maximum intercuspation while initial polymerization occurs. Remove the RPD and place it in warm water until polymerization is complete; remove excess resin from both surfaces, on the tissue side and by the vent hole (Figures 6.4.5 and 6.4.6). Remove acrylic resin contacting the gingival margins around the overdenture abutment.

The overdenture patient must be instructed on proper home care and oral hygiene procedures to ensure long-term success. Fluoride should be applied on overdenture abutments to help prevent dental caries. Treat the patient the day of the overdenture abutment preparation and at subsequent recall appointments with a 2-minute application of 0.5% acidulated phosphate fluoride followed by a 2-minute application of 0.4%



**Figure 6.4.5.** Autopolymerizing acrylic resin extending beyond the prepared tissue surface of the denture base or contacting the gingival margins around the overdenture abutment is removed.



**Figure 6.4.6.** Autopolymerizing acrylic resin that flowed through the vent hole in the denture base is finished and polished flush with the denture tooth.

stannous fluoride. Instruct the patient to use a 0.4% stannous fluoride gel daily after thorough cleaning of the prosthesis and the natural teeth. The stannous fluoride gel should be used with a toothbrush to protect both the overdenture abutments and the other remaining natural teeth. The gel is placed in the concavity within the denture base over the overdenture abutment, then the RPD is placed in the patient's mouth for 5 minutes; the patient can remove the partial denture and expectorate, but not rinse the mouth.

## Swing-lock removable partial dentures

A swing-lock removable partial denture, first described by Simmons in 1963, consists of a hinged labial arm attached to a conventional major connector. The labial arm is connected to the removable partial denture framework at one end by a hinge and at the other end by a locking mechanism (Figure 6.4.7). The hinge action allows the labial arm to be positioned intimately against the gingival tissues and into undercuts on the labial surfaces of the natural teeth and alveolus. The position of the labial arm into soft- and hard-tissue undercuts disguises the thickness that is acceptable for patient comfort and, at times, esthetics; the labial arm does not require the bulk of a labial bar major connector for rigidity.



**Figure 6.4.7.** The labial arm of a swing-lock removable partial denture is connected to the framework at one end by a hinge and at the other end by a locking mechanism.

The labial arm is designed with small vertical I-bar projections in contact with the labial surfaces of the anterior natural teeth. If use of vertical projection bars produces a poor esthetic result or if extensive gingival recession has occurred, the labial arm can be designed with acrylic resin retention components. Retention and stabilization for a swing-lock removable partial denture are provided by either the vertical projection arms or the acrylic resin denture base attached to the labial arm contacting most or all of the remaining natural teeth.

### *Advantages of swing-lock removable partial dentures*

A swing-lock removable partial denture provides an inexpensive method to achieve board stress distribution using all or most of the remaining natural teeth for partial denture retention, stability, and support. If a natural tooth is lost over time, a denture tooth can be added to the major connector of a swing-lock removable partial denture through simple clinical and laboratory repair procedures.

### *Disadvantages of swing-lock removable partial dentures*

The primary concern with a swing-lock removable partial denture is the concentration of rotational forces on the remaining anterior natural teeth firmly held by the labial hinged and locked arm. Occlusal forces can cause displacement of the distal-extension denture base; as the denture base moves toward the residual ridge, the labial arm on the opposite side of the principal fulcrum line moves superiorly and posteriorly such that the anterior natural teeth grasped by the labial arm tend to rotate distally.

The labial arm of a swing-lock removable partial denture can also compromise the esthetic results for partially edentulous patients with

short or extremely mobile lips. Even when an acrylic resin denture base is added to the labial arm, obtaining esthetic adaptation of the acrylic resin denture base is difficult and limited by the hinge movement of the labial arm.

### Indications for swing-lock removable partial dentures

Indications for the use of swing-lock removable partial dentures in the treatment of partially edentulous patients include

- Few remaining natural teeth for a conventional RPD (Figure 6.4.8).
- Periodontally compromised natural teeth.
- Remaining natural teeth in poor position to support a conventional RPD.
- Excessive alveolar bone loss either through traumatic injury or surgical intervention.

### Design considerations for swing-lock removable partial dentures

The vertical projection arms on the labial arm will contact the natural teeth below the survey lines, as will a resin veneer added for esthetic concerns. The other components of the swing-lock removable partial denture will contact the natural teeth above the survey lines. Selection of a major connector for a swing-lock removable partial denture should provide as much support and stability as possible; the complete-palate major connector is commonly indicated for a maxillary swing-lock RPD and the lingual plate major connector for a mandibular swing-lock removable partial denture. The latter implies the remaining mandibular natural teeth are plated with the plating positioned above the survey lines.



**Figure 6.4.8.** Five mandibular anterior natural teeth provide too few remaining teeth for a conventional extracoronal clasp-retained removable partial denture.

The labial arm is hinged "open" during placement of a swing-lock removable partial denture. With the labial arm closed, the lingual plating and rests in rest seats resist partial denture movement toward the supporting tissues. In addition to lingual plating, properly prepared rest seats ensure occlusal forces are directed down the long axes of the natural teeth. The vertical projection arms on the labial arm resist partial denture movement away from the supporting tissues. In the design of a swing-lock RPD, remaining natural teeth collectively resist RPD movement in function.

The material of choice for a swing-lock removable partial denture framework should provide rigidity, strength, and wear resistance required for the hinge and locking mechanisms; a chrome alloy is the material of choice for a swing-lock RPD.

### Clinical considerations for swing-lock removable partial dentures

In order to produce the best esthetic result for a partially edentulous patient with short or mobile lips, the patient is asked to say "shepherd" and "sheriff" to produce maximum movement of the lips and exposure of the anterior natural teeth. Lines are drawn on the master cast to indicate the position of maximum lip movement relative to the remaining natural teeth. If the vertical projection arms of the labial arm cannot be positioned below the line on the natural teeth indicating maximum lip movement, the I-bars are visible and compromise the esthetic results (Figure 6.4.9). Acrylic resin denture base mate-



**Figure 6.4.9.** The vertical projection arms of the labial arm of a swing-lock removable partial denture can compromise overall esthetic results during speech.



**Figure 6.4.10.** After saliva has been removed and the impression has been disinfected, interproximal material tears in the impression material can be repositioned and luted in place with sticky wax.

rial can be used as a veneer to cover the vertical projections but may still compromise overall esthetic results.

The hinge and lock mechanism is positioned for convenient manual manipulation by the patient, both opening and closing. Select the side opposite the patient's dominant hand to position the lock mechanism. For example, it is easier for a right-handed person to open the locking mechanism when the locking mechanism is located on the left side of the swing-lock removable partial denture.

The impression must extend into the buccal and labial vestibules to the full extent; an irreversible hydrocolloid impression material is the impression material of choice for this particular situation. If a stock impression tray is used to make the master impression, modeling plastic impression compound can be used to border mold the buccal and labial flanges of the stock impression tray in order to provide proper impression tray extension. If a stock impression tray is used, edentulous areas of the partially edentulous arch should also be modified with modeling plastic impression compound or a polyvinylsiloxane material. If the anterior natural teeth are labially inclined, a custom impression tray may be required to record accurately the buccal and labial vestibules. If a custom impression tray is made to use irreversible hydrocolloid impression material, there must be sufficient space around the natural teeth and supporting tissues to allow for 4.0–6.0 mm of irreversible hydrocolloid impression material. Use a heavy-bodied irreversible hydrocolloid impression material to make the master impression. If the material tears when removed from undercut embrasure spaces, the impression material can be carefully repositioned and luted in place (Figure 6.4.10).

Fitting a swing-lock removable partial denture framework to natural teeth requires the labial arm open when the RPD is positioned intraorally. Closure of the labial arm of a swing-lock framework should not be attempted until lingual and occlusal areas of the framework have been accurately fitted to the natural teeth. After the swing-lock framework is accurately fitted to the natural teeth, pressure is applied to the labial arm starting at the hinge mechanism and progressing along the labial arm toward the locking mechanism. Avoid pinching the patient's lip as the labial arm is closed.

Optimum support and stability from the residual ridge are critical to the success of swing-lock removable partial denture treatment. Impression procedures should delineate the peripheral extent of the denture base over as large an area as possible. Significant movement of the denture base

toward the residual ridge will result in increased mobility of the remaining natural teeth since the natural teeth are firmly engaged by the labial arm of the swing-lock removable partial denture. Excessive displacement of the supporting soft tissues and overextension of the denture base borders when making the impression can contribute to natural tooth loss, since both intraoral conditions can generate continuous forces on the remaining natural teeth.

Oral hygiene is extremely important to the success of swing-lock removable partial denture treatment because a swing-lock removable partial denture's extensive tooth coverage complicates maintenance of adequate oral hygiene. Frequent professional oral hygiene maintenance and clinical examination are essential to the success of swing-lock removable partial denture treatment. In order to maintain optimum support and stability from the residual ridge, the denture base must be relined when any appreciable movement of the denture base is observed. The reline impression of the denture base supporting tissues should be made with the labial arm of the swing-lock removable partial denture closed to ensure that the framework is in the correct position throughout the impression procedures. The reline protocol is presented in chapter 5.

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# 7 Geriatrics and Removable Partial Dentures

The geriatric population has seen remarkable growth that is having an effect on dentistry and particularly removable partial dentures. The growth each year in the elderly is primarily due to the aging Baby Boomers, low fertility rates, and advances in medicine that have increased life expectancy.

Functional abilities affect whether or not a person is able to perform the activities of daily living (ADLs). Performance of ADLs is of concern to the dentist because it is an indicator of the ability to manage and maintain oral health and a dental removable prosthesis if present. Functionally dependent and frail older adults will rely more on others for assistance in caring for needs.

There are challenges facing the older population besides possibly experiencing compromised functional capabilities. These are medical conditions, psychosocial issues, access to care, and possible limited finances. In spite of the challenges, the elderly are also experiencing positive factors such as longer tooth retention, improved dental treatment technology, better oral health care, increased dental visits, and concern with esthetics as well as maintaining and replacing missing teeth.

In order to better understand the impact of the aging population in dentistry and removable partial dentures, topics of demographics, and psychosocial, physical, and psychological changes are discussed.

## Demographics

Population changes are a dynamic force that influences all phases of industry including the dental profession. It is very evident that the growth of the older population, persons 65 years or older, has had such an effect. For example, there is an increase in the number of retirement homes, assisted living, and long-term care or nursing homes. The effects seen in dentistry have been increased needs for periodontal, restorative, prosthodontic, endodontic, and preventive services.

Since the year 1900, the United States has seen a tenfold increase in the 65 years and older population. One in every eight Americans is older and represents 12.4% of the U.S. population. The population age 65 and older is expected to increase from 35 million in 2000 to 40 million in 2010 and then to 55 million in 2020. This is an increase of 36% for that decade.

In addition, the 85 and older population is the fastest growing cohort of the elderly. The 85 and older population is expected to increase

from 4.2 million in 2000 to 6.1 million in 2010, and then to 7.3 million in 2020. The 44% increase for the decade in the 85 and older group is mainly due to the Baby Boomers aging and increasing life expectancies. The 85 and older population is often referred to as the oldest old. The growth rate of the 65 and older population is expected to slow after 2030 when the last Baby Boomers enter the older cohort. However, the older elderly group is expected to grow rapidly after 2030. Figure 7.1 shows the dramatic population changes and projections. Baby Boomer projections are highlighted with contrasting color.

Scientific research studies have shown that edentulism rates are declining. Edentulism in the United States declined from 10.8% in 1988–1994 to 7.7% in 1999–2002. In 2004, only 27% of elderly were edentulous. Studies have also shown that tooth loss is not a normal part of becoming older. Instead edentulism rates are influenced by culture, socioeconomic factors, access to care, state residence, attitudes toward oral health, diet, and nutrition. Figures 7.2 and 7.3 show declining edentulism rates in the United States.

Edentulism is declining, and approximately 74% of people 75 years and older on average are mostly dentate with an average of less than ten teeth missing. Missing teeth can impact the psychosocial, nutritional, and overall well-being of an individual. There is still a high chance that those over 65 will require some replacement of missing teeth. The majority of elderly pay dental expenses out of pocket. Only 22% of elderly have dental insurance. In most situations, the ideal replacement of missing teeth is implants. For older people on fixed incomes with no dental insurance who have to pay out of pocket, implants can be prohibitive. Instead, the more affordable option would be a removable partial denture prosthesis. Unless government efforts are made to assist the elderly with the cost of complex dental treatments such as implants, there will remain a need for removable partial denture prosthodontics.

## Changes in the geriatric patient

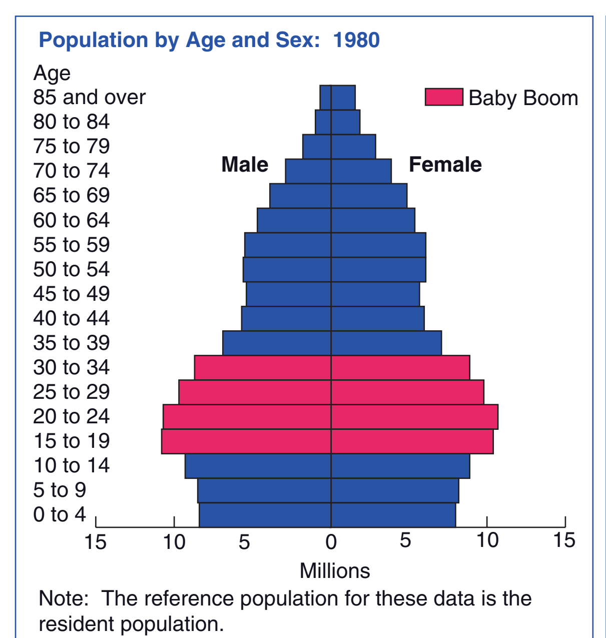
### *Physical, physiological, and psychological changes*

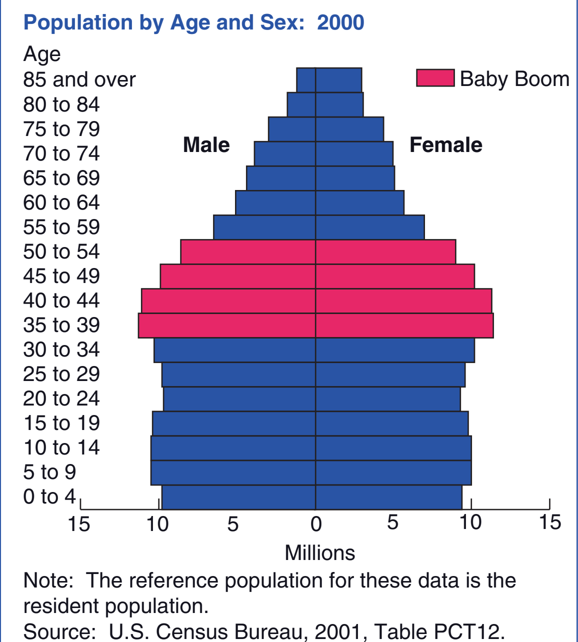
The longevity of people is increasing and with it mortality rates are decreasing. As age increases, the chances of developing one or more systemic conditions increase. The presence of one disease is morbidity and two or more diseases is co-morbidity. The majority of the morbid conditions become chronic and often affect life and ADLs. The most common chronic conditions of the elderly are arthritis, hypertension, heart disease, visual changes, and diabetes mellitus. Systemic conditions impact motor and bodily function, coordination, and thought processes.

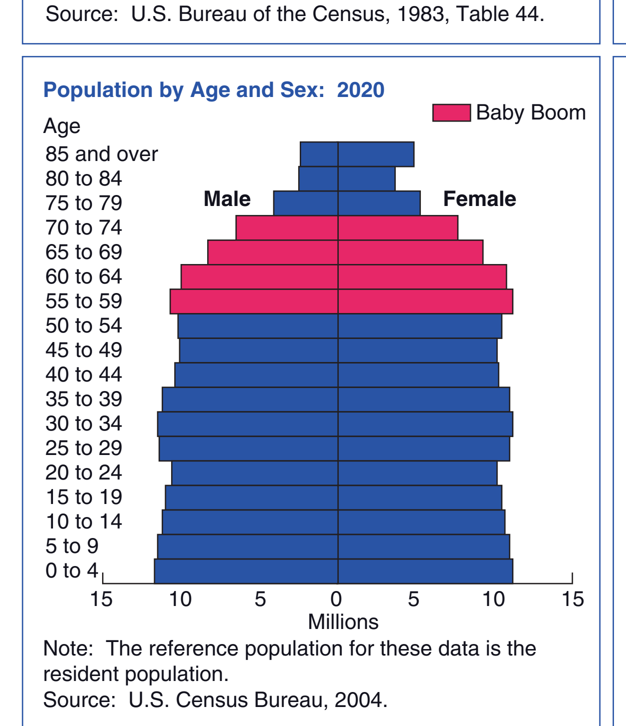
Normal physical changes of aging are loss in muscle tone, skeletal change such as posture, and visual and hearing impairment. Physiologic changes also may occur such as incontinence, digestive changes, and gait and balance disorders. An increase in psychological changes are also seen such as dementia, depression, and sleep disorders. Due to these changes, the elderly with advancing age can become frail.

There is a wide range in the functional abilities of those who are aging. Three functional groups of the elderly are functionally independent, functionally dependent, and frail. The functional categories are based on the ability to seek dental care independently and travel to dental visits. The functionally dependent will rely on others for accessing the dental office. Frailty in older adults is characterized by a lower ability for independent living; these people require assistance with ADLs. Frail elderly have low physical abilities, muscle weakness, slowed performance, poor endurance, and unintentional weight loss due to malnutrition.

Normal aging processes and systemic conditions can impact a patient's ability to adapt to a removable partial denture. Loss of muscle and motor function will affect the ability to cleanse, place, and maintain a removable partial denture. Psychological changes will impact the desire and



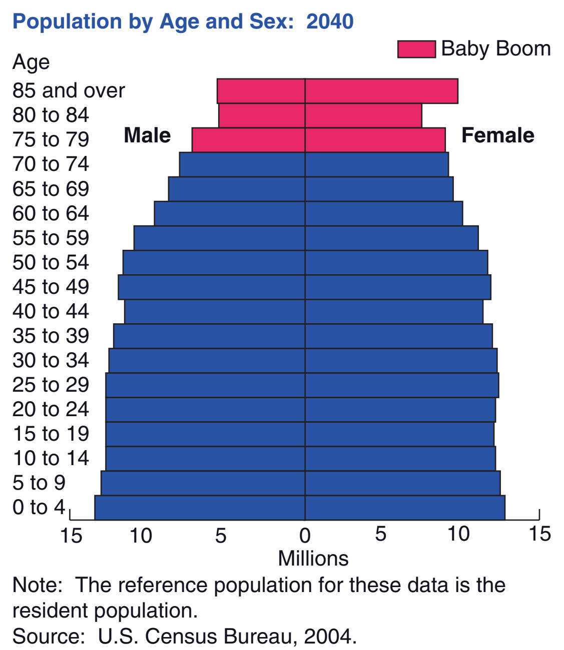




**Figure 7.1.** Population changes and projections in the United States, 1980–2040. Population projections for 2030 show a large increase in the 65 years and older cohort when compared to the same cohort from 1980. Part of this growth is due to increased life expectancy. Baby Boomers are highlighted in red. Source: Issued December 2005. Current Population Reports. Special Studies. http://www.census.gov/prod/2006pubs/p23-209.pdf. Accessed September 10, 2007. Public Domain.

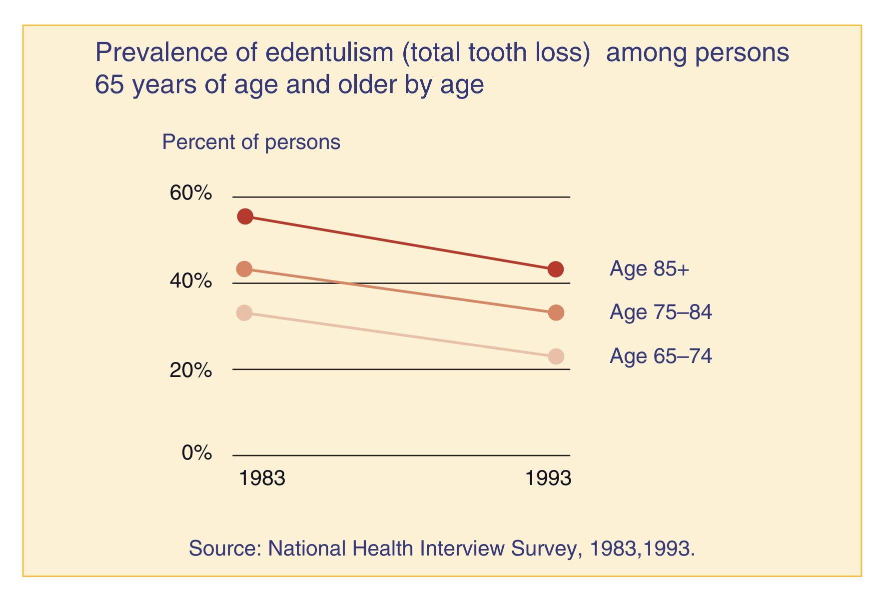



**Figure 7.2.** Prevalence of edentulism 65+ years in the United States, 1983–1993. In a 10-year comparison from 1983 to 1993, rates of edentulism are declining in the 65 years and older ages. Rates are expected to continue to decline in the elderly. Source: Vargas, C., Kramarow, E., Yellowitz, J. The Oral Health of Older Americans. CDC, Aging Trends No. 3. Hyattsville, MD: National Center for Health Statistics. March 2001. Public Domain.

compliance to wear a partial as well as the maintenance of it.

## *Arthritis*

The most common and prevalent disease of the elderly is arthritis. In the United States, it is the most common cause of physical disability and is prevalent in half of those 65 and older. Arthritis is the nation's leading cause of disability. Symptoms include morning stiffness, joint pain, and sometimes inflammation and swelling. Women are more prone to develop arthritis. Arthritis can occur in different diseases such as rheumatoid arthritis, osteoarthritis, diabetes, heart disease, gout, systemic lupus, and fibromyalgia.

As the arthritic diseases progress, the ability to cleanse the mouth and remove prosthesis from the mouth may become more difficult. Difficulty in opening the mouth from temporomandibular joint (TMJ) changes can occur. The electric toothbrush or modifying brushes to improve grasp is very helpful to these patients.

## *Stroke*

According to the Centers for Disease Control and Prevention (CDC), stroke is the leading cause of death in the United States. It often leads to long-term physical disability. The majority of strokes occur in persons over the age of 65. After age 55, the risk of stroke doubles with each decade of life. The physical changes seen from a stroke can vary depending on the severity of the stroke. Disability depends on the size, location, and type of lesion. Usually a stroke affects one side of the body, termed hemiplegia. The result is a loss of muscle strength and proprioception.

As a result, it can become difficult to remove and place a removable partial dental prosthesis. Other oral complications seen with stroke are difficulty in swallowing and a flaccid tongue. A unilateral partial is contraindicated in stroke patients because aspiration risk is high. Speech can also be altered, and wearing an appliance can make speech more difficult. Oral hygiene often becomes poor and cleaning a removable appliance can be difficult. An electric tooth-

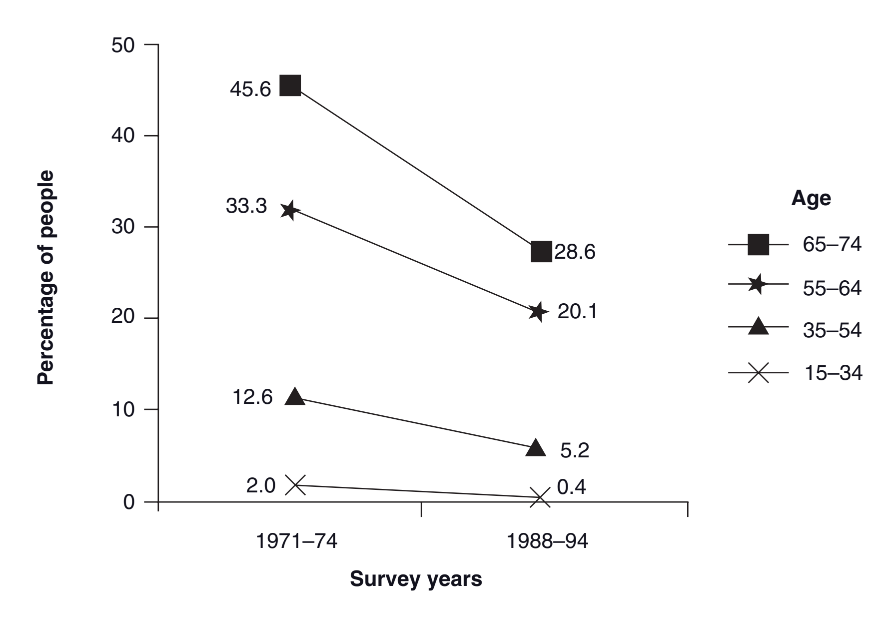



**Figure 7.3.** Declining rate of edentulism in the United States, 1971–1994. In 1994, only 28.6% of the 65–74-year-old cohort was edentulous. In 1974, this same cohort had edentulous rates of 45.6%. The downward trend in all age groups shows that more of the population are retaining their natural teeth. Source: United States Department of Health and Human Services. Report. Oral Health in America: A Report of the Surgeon General. 2000. Public Domain.

brush or large-handle brushes are helpful to the stroke patient.

## *Dementia*

Dementia is a common age-related disease. After the age of 65 dementia doubles every 5 years. The prevalence of dementia increases with age. At age 60 the prevalence is 1% and then increases to 40% at age 85. Dementia is chronic in 65% of the geriatric population. The majority of dementia cases are nonreversible. Common dementia disorders are Alzheimer's disease, vascular dementia, and dementia caused by Parkinson's disease.

Dementia symptoms cover a wide range of problems including memory loss and higher cognitive functioning. With the progression of a dementia disorder, the ability to perform normal ADLs becomes increasingly difficult. Maintaining oral health including a removable partial denture may become impossible. Like the stroke patient, aspiration risk is a concern.

It is important for the dentist to communicate early with family and caregivers to provide instruction and education on assisting with oral hygiene and removing and cleaning a removable dental prosthesis. The rates of edentulism are declining but there are more challenges that the dentist faces in preserving oral health. There are higher rates of caries especially on root surfaces. Root caries can be attributed to poor oral hygiene as well as medications used in the treatment of dementia. These medications cause salivary dysfunction that leads to xerostomia. As the older population is growing, it is expected that the number of dementia cases will increase.

### *Xerostomia*

Systemic diseases and the treatments such as medications can cause xerostomia or dry mouth in geriatric patients. Dry mouth is common in the elderly and causes difficulty eating, drinking, and speaking. There is also a breakdown in host defense that can lead to an increase in oral infections as well as caries. Medications are the most common cause of dry mouth. Of the most commonly prescribed drugs, 80% cause xerostomia.

Patients that wear a removable dental prosthesis and have dry mouth experience several difficulties. There is an increase in denture sores, and retention of the removable prosthesis is decreased. Mucosal surfaces in the mouth become very dry and friable. Bad breath and burning mouth are also common. Speech and eating are difficult and cause avoidance of social interaction. Dry mouth patients are more susceptible to oral candidiasis. The oral fungus can also grow on a removable dental prosthesis.

Patient education with emphasis on oral hygiene and prevention of oral disease is essential. Frequent recall dental visits are necessary to monitor oral conditions. Home topical fluorides and antimicrobial rinses are useful to prevent oral disease. Dry mouth patients can also use sialologues or medications that stimulate salivary flow. Some stimulation of salivary flow can occur with the use of sugar-free chewing gum, candies, and mints. Patients should be instructed to immerse the removable partial denture in 0.12% chlorhexidine once or twice a day to prevent fungal growth. Patients should be instructed to increase fluid intake while eating and carry bottled water at all times.

## Conclusion

The older population is increasing and should continue to show a decline in tooth loss. This trend is expected due to patient education, improved oral disease prevention, fluoride, new treatment technology, and increased dental visits. As the geriatric population continues to increase, the dentist must be prepared to handle the need for complex dental treatment as seen in elderly medically compromised patients. Emphasis should be placed on training dental students in geriatric medicine and dentistry. When surveyed, 25% of dental students indicated more geriatric training was needed in the dental school curriculum. Most schools have a geriatric didactic program but some do not have clinical geriatric programs. The dentist should be better trained in understanding the medical, pharmacological, and psychological needs of the geriatric patient. Specialized dental skills and training are essential for the dentist to render appropriate treatment for the geriatric patient.

Edentulism is declining and the elderly will have natural dentition with some tooth loss. The need for removable partial dentures will continue into the future. Dental schools will always have the need to educate students on sound removable partial denture design. With new technology, materials and designs for removable partial dentures should continue to improve.

The majority of elderly pay out of pocket for dental treatment. For many geriatric patients, the cost of replacing missing teeth is unaffordable. Dentistry must take a more active roll in lobbying for increased dental benefits for the elderly at federal and state levels. Involvement in elderly community projects is another area in which dentistry can make a difference in improving the oral health of the geriatric patient. Educating the aging population on prevention of oral disease, the maintenance of existing dentition, and the replacement of missing teeth can significantly improve quality of life.

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# 8 Clinical Patient Scenarios

## 8.1 Clinical patient scenario #1: maxillary FPD and mandibular Class II RPD with survey crowns

> Maxillary fixed partial denture and crowns oppose a mandibular unilateral distal-extension removable partial denture. Survey crowns in the mandibular arch provide ideal anatomical features for multiple abutment teeth to retain and support the mandibular partial denture.

A 48-year-old African-American female was referred for prosthodontic evaluation. The patient's past dental history revealed a treatment course including extraction of teeth, amalgam and composite resin restorations, fabrication of a maxillary removable partial denture (RPD), and annual oral prophylaxis. The patient revealed that she still had the maxillary RPD made for her, but she could never tolerate wearing the prosthesis due to a "poor fit."

The patient's chief complaint was a desire for replacement of her missing teeth and repair of defective and stained restorations. The diagnoses for the patient included localized marginal gingivitis; mandibular bilateral lingual tori and a maxillary right premolar area osseous defect; worn, discolored, or defective restorations; partiallism edentulous with extruded and migrated teeth; functionally inadequate posterior occlusion; and compromised esthetics.

Diagnostic impressions were made of the patient's maxillary and mandibular arches, and the diagnostic casts were mounted in a semiadjustable articulator. A diagnostic wax-up confirmed that a mutually protected occlusion could be achieved.

The treatment plan for this patient consisted of an oral prophylaxis, removal and replacement of defective and/or discolored amalgam and composite resin restorations, limited occlusal adjustment to eliminate deflective contacts, fixed partial denture to replace nos. 4 and 5, partial veneer crowns nos. 14 and 15, complete crowns nos. 13 and 27, surveyed complete crowns nos. 20, 28, 29, and 30, and a mandibular unilateral distal-extension RPD with cast metal crowns as replacements for teeth nos. 18 and 19 (Figures 8.1.1–8.1.11).



**Figure 8.1.1.** Pretreatment intraoral view of patient with teeth in maximum intercuspation.



**Figure 8.1.2.** Posttreatment intraoral view of patient with maxillary fixed partial denture and crowns opposing mandibular survey crowns and a unilateral RPD.



**Figure 8.1.3.** Pretreatment right lateral view of patient with teeth in maximum intercuspation.



**Figure 8.1.4.** Posttreatment right lateral view of patient with circlet retentive clasp located on the facial surface of survey crown no. 30.



**Figure 8.1.5.** Pretreatment left lateral view of patient with extruded teeth nos. 14 and 15.



**Figure 8.1.6.** Posttreatment left lateral view of patient with 1/2-T retentive clasp on facial surface of survey crown no. 20 and 3/4 gold crowns on nos. 14 and 15 opposing prosthetic replacement teeth nos. 18 and 19.



**Figure 8.1.8.** Posttreatment maxillary occlusal view of patient with four-unit fixed partial denture maxillary right and single crowns maxillary left.



**Figure 8.1.7.** Pretreatment maxillary occlusal view of patient with buccal osseous defect in the maxillary right premolar region.



**Figure 8.1.9.** Pretreatment mandibular occlusal view of patient with defective and/or missing amalgam restorations.



**Figure 8.1.10.** Mandibular occlusal view of patient with survey crowns nos. 20, 28, 29, and 30 designed to restore defective restorations and provide rest seats, guide planes, and retentive undercuts to support and retain a mandibular RPD.



**Figure 8.1.11.** Posttreatment occlusal view of patient with multiple survey crowns and a mandibular unilateral distal-extension RPD replacing tooth nos. 18 and 19.

## 8.2 Clinical patient scenario #2: maxillary complete denture and mandibular Class I RPD with runner bar

Maxillary complete denture opposes mandibular bilateral distal-extension removable partial denture. A runner bar modification to the metal framework provides rigidity and support for the anterior replacement teeth and acrylic resin denture base.

A 66-year-old Caucasian male was referred for prosthodontic evaluation. The patient's past dental history revealed a treatment course including extraction of teeth, wear of an immediate maxillary complete denture, and an acrylic resin mandibular RPD.

The patient's chief complaint was a desire for replacement of the immediate maxillary complete denture and a new mandibular RPD that would not fracture in the anterior tooth segment. The diagnoses for the patient included localized marginal gingivitis, maxillary midline tori, partially edentulous mandibular arch, functionally inadequate posterior occlusion, excessive vertical bone loss of the mandibular anterior residual ridge, and ill-fitting maxillary and mandibular removable prostheses.

Diagnostic impressions were made of the patient's maxillary and mandibular arches. The mandibular cast was surveyed and a color-coded design was drawn on the cast. A metal runner bar was designed in the anterior modification space of the mandibular RPD metal framework to improve rigidity and provide support for the anterior denture teeth and denture base.

The treatment plan for this patient consisted of surgical removal of the maxillary midline tori, oral prophylaxis, fabrication of a new maxillary complete denture, and fabrication of a definitive mandibular RPD with a metal runner bar modification in the anterior region (Figures 8.2.1–8.2.20).



**Figure 8.2.1.** Maxillary immediate complete denture and mandibular acrylic resin RPD worn by patient.



**Figure 8.2.2.** Example of dislodged acrylic resin denture base and teeth due to fracture of the metal retentive component in the anterior edentulous area of a mandibular RPD.

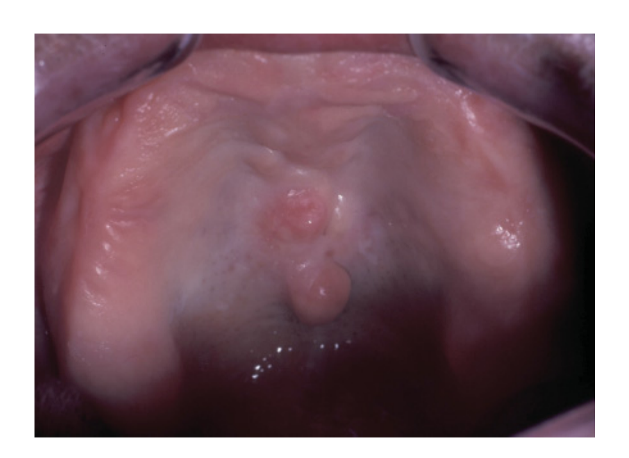


**Figure 8.2.3.** Midline tori noted on patient's palate.



**Figure 8.2.4.** Posttreatment intraoral view of patient 1 week after surgical removal of palatal tori.

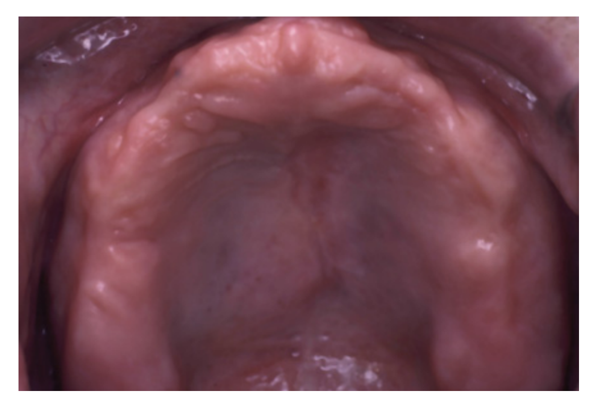


**Figure 8.2.5.** Posttreatment intraoral view of healed palate 1 month after tori removal.

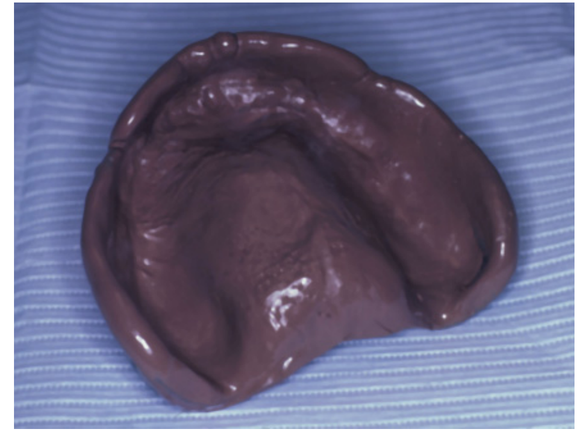


**Figure 8.2.6.** Maxillary complete denture polysulfide final impression.




**Figure 8.2.7.** Mandibular diagnostic cast with runner bar design in anterior edentulous region.



**Figure 8.2.8.** Mandibular rim-lock metal impression tray customized with modeling plastic.



**Figure 8.2.9.** Mandibular RPD alginate final impression.

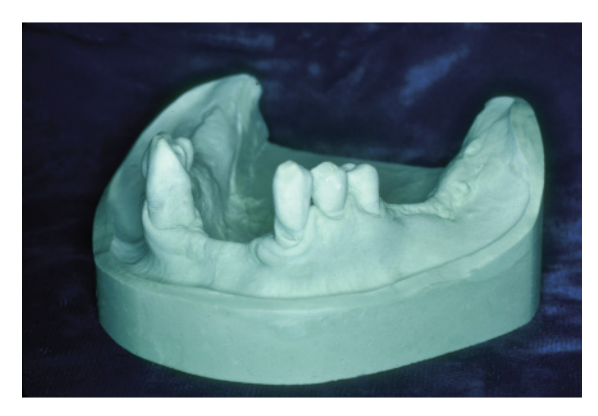


**Figure 8.2.10.** Mandibular master cast.



**Figure 8.2.11.** Frontal view of refractory cast with 14-gauge round wax runner bar and vertical struts placed in anterior edentulous region.

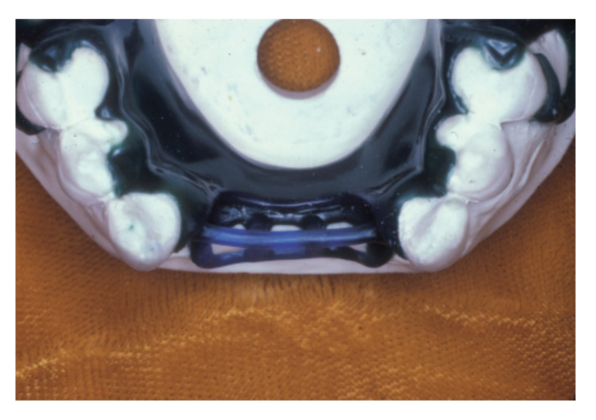


**Figure 8.2.12.** Occlusal view of wax runner bar aligned with curvature of residual ridge.



**Figure 8.2.13.** Metal framework with runner bar designed to support the mandibular anterior acrylic resin teeth and denture base.



**Figure 8.2.15.** Lingual view of anterior denture teeth placed to fit curvature of metal runner bar.



**Figure 8.2.14.** Anterior denture teeth ground and fitted to metal runner bar.



**Figure 8.2.16.** Final anterior denture teeth and waxed denture base conceal metal runner bar.



**Figure 8.2.17.** Trial wax-up of maxillary and mandibular removable prostheses.



**Figure 8.2.19.** Posttreatment occlusal view of mandibular RPD with runner bar modification in anterior edentulous region.



**Figure 8.2.18.** Processed maxillary complete denture and mandibular RPD.



**Figure 8.2.20.** Posttreatment frontal view of maxillary complete denture opposing mandibular bilateral distal-extension RPD.

## 8.3 Clinical patient scenario #3: maxillary full-arch reconstruction with survey crown and FPD and Class I removable partial overdenture with internal attachment

Maxillary bilateral distal-extension removable partial denture opposes mandibular full-arch natural dentition. Survey crowns, fixed partial denture, and a partial overdenture abutment provide retention and support for removable partial denture with an internal attachment.

A 45-year-old Hispanic female was referred for prosthodontic evaluation. The patient's past dental history revealed a treatment course including extraction of teeth 20 years ago, root canal therapy, amalgam and composite resin restorations, fabrication of a maxillary RPD 7 years ago only worn by the patient for 1 year due to discomfort, and current periodontal therapy for a gingival abscess.

The patient's chief complaint was to have further dental treatment done subsequent to the periodontal treatment. The diagnoses for the patient included localized periodontitis with +1 mobility and irreversible pulpitis maxillary right second premolar, partially edentulous maxillary arch, defective composite resin restorations in numerous maxillary teeth, functionally inadequate posterior occlusion, bilateral temporomandibular joint popping with mild discomfort at mid to late opening, and compromised anterior esthetics.

Diagnostic impressions were made of the patient's maxillary and mandibular arches, and the diagnostic casts were mounted in centric relation in a semiadjustable articulator. A diagnostic wax-up confirmed that a mutually protected occlusion could be achieved. A maxillary occlusal splint was fabricated for evaluation and resolution of the temporomandibular dysfunction and stabilization of maxillomandibular occlusal relations.

The treatment plan for this patient consisted of endodontic treatment no. 4, selective occlusal adjustment, metal-ceramic crowns nos. 6, 7, 8, 9, 10, a fixed partial denture for nos. 11–13, cast metal dowel and coping for partial overdenture abutment no. 4, and a maxillary removable partial overdenture with an internal attachment (Figures 8.3.1–8.3.18).



**Figure 8.3.1.** Pretreatment intraoral view of patient with multiple missing maxillary posterior teeth and numerous defective restorations.



**Figure 8.3.2.** Posttreatment intraoral view of patient with reconstructed maxillary dentition using fixed single crowns, FPD, overdenture abutment, and a removable partial overdenture.



**Figure 8.3.3.** Pretreatment right lateral view of patient with missing maxillary posterior teeth and periodontally compromised tooth no. 4.



**Figure 8.3.4.** Posttreatment right lateral view of patient with survey crown no. 6 and maxillary removable partial overdenture (abutment tooth and attachment no. 4 hidden under denture base).



**Figure 8.3.5.** Pretreatment left lateral view of patient with missing maxillary posterior teeth.



**Figure 8.3.6.** Posttreatment left lateral view of patient with surveyed fixed partial denture nos. 11–13 and maxillary removable partial overdenture.

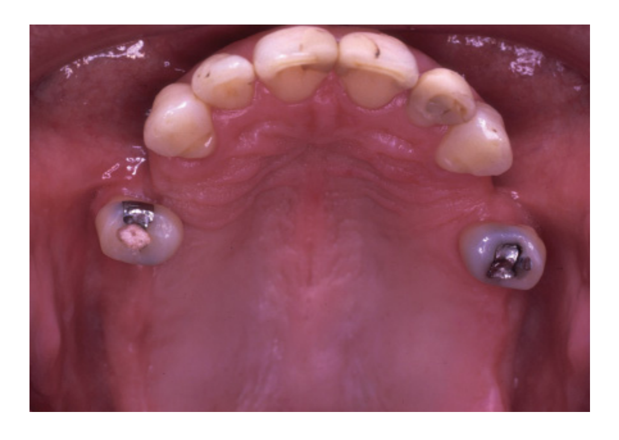


**Figure 8.3.7.** Pretreatment maxillary occlusal view of patient with multiple missing posterior teeth and periodontally compromised tooth no. 4.



**Figure 8.3.9.** Maxillary occlusal view of provisional bis-acryl composite resin restorations worn by patient to verify esthetics, phonetics, and function.

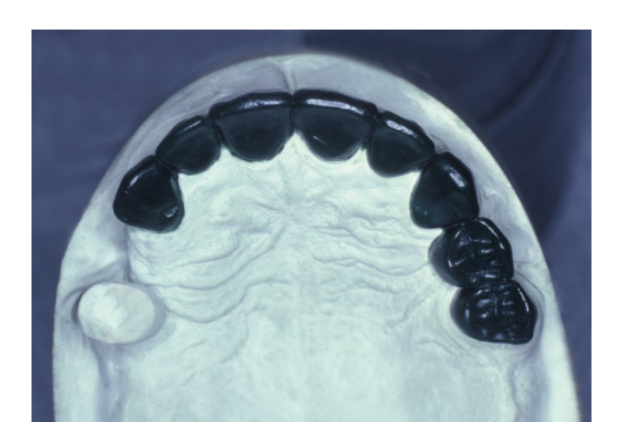


**Figure 8.3.8.** Diagnostic wax-up provides a "blueprint" for an esthetic and functional mutually protected occlusion.



**Figure 8.3.10.** Metal-ceramic crowns and fixed partial denture cemented in maxillary arch. Note cingulum rests on nos. 6 and 11 lingual surfaces and distal-occlusal rest on no. 13.



**Figure 8.3.11.** Metal dowel and coping no. 4 will serve as maxillary partial overdenture abutment.

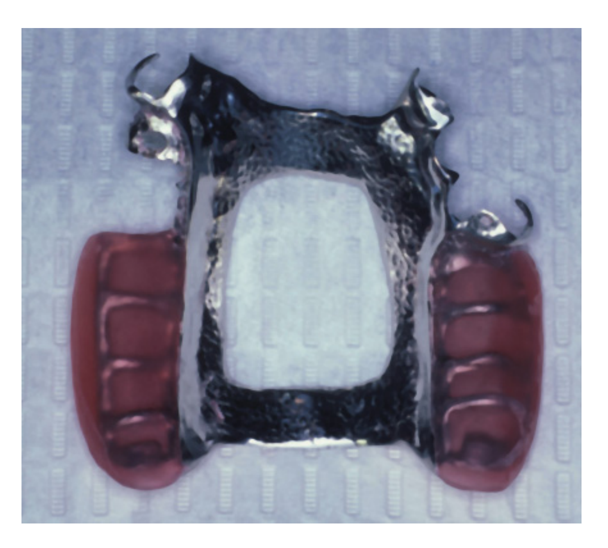


**Figure 8.3.13.** Autopolymerizing acrylic resin record bases added to metal framework.



**Figure 8.3.12.** Metal removable partial denture framework fitted to surveyed crown no. 6 and fixed partial denture nos. 11–13.

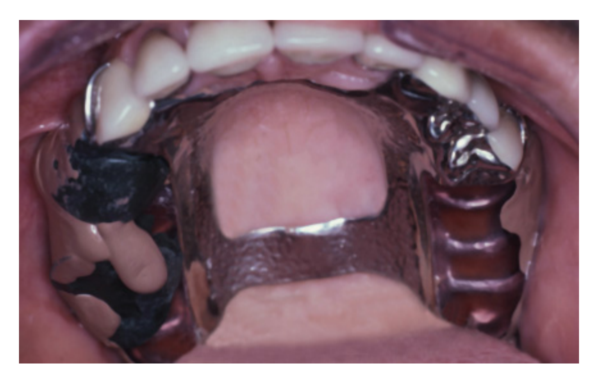


**Figure 8.3.14.** Polysulfide impression used to record partial overdenture abutment and residual ridge relations to natural teeth.

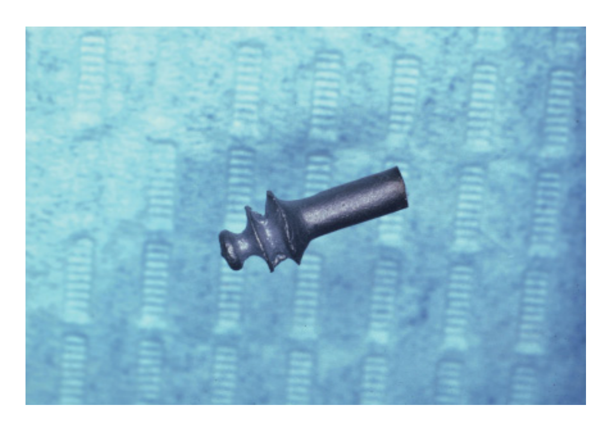


**Figure 8.3.15.** Cast metal dowel and coping abutment analog.



**Figure 8.3.17.** Altered master cast (with embedded analog) used for processing O-ring attachment at tooth no. 4 and acrylic resin denture bases to RPD framework.

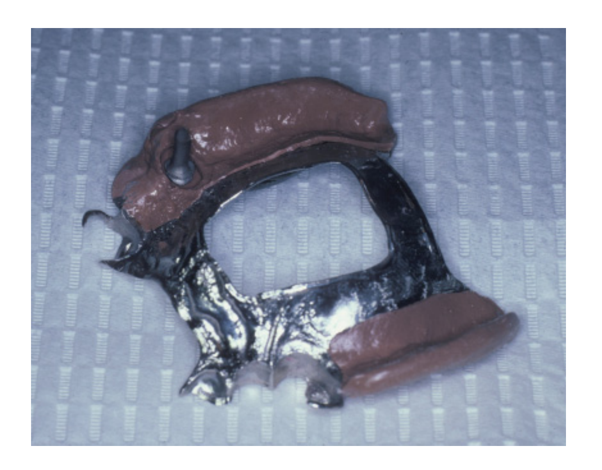


**Figure 8.3.16.** Dowel and coping abutment analog placed in the altered cast impression.



**Figure 8.3.18.** Posttreatment occlusal view of patient with maxillary bilateral distal-extension removable partial over-denture and internal retentive attachment in tooth no. 4 position.

## 8.4 Clinical patient scenario #4: maxillary immediate complete denture and mandibular Class I removable partial overdenture with natural tooth abutments

> Maxillary immediate complete overdenture opposes mandibular bilateral distal-extension removable partial overdenture. Endodontically treated teeth and a survey crown provide support for the mandibular removable partial overdenture.

A 53-year-old Caucasian male was referred for prosthodontic evaluation. The patient's past dental history revealed a treatment course for periodontal problems, extraction of teeth, root canal therapy, amalgam and composite resin restorations, crowns, and an anterior fixed partial denture.

The patient's chief complaint was to resolve his dental problems without having periodontal surgery. The diagnosis for the patient was based on multidisciplinary consults and included severe generalized periodontitis, severe caries on several posterior teeth, malpositioned and extruded posterior teeth, and partially edentulous maxillary and mandibular arches. A hopeless periodontal prognosis was made for the maxillary anterior fixed partial denture.

Diagnostic impressions were made of the patient's maxillary and mandibular arches, and the diagnostic casts were mounted in a semiadjustable articulator. Preliminary treatment to address hopeless and nonrestorable dental conditions was approved by the patient and included extraction of nos. 3, 5, 7, 8, 9, and 14 and insertion of a maxillary acrylic resin interim removable partial denture.

The treatment plan for this patient consisted of endodontic treatment nos. 4, 6, 10, and 13 to serve as abutments for a maxillary immediate complete overdenture, and endodontic treatment nos. 18, 30, and 31 and a surveyed complete crown no. 29 to serve as abutments for a mandibular removable partial overdenture (Figures 8.4.1–8.4.20).

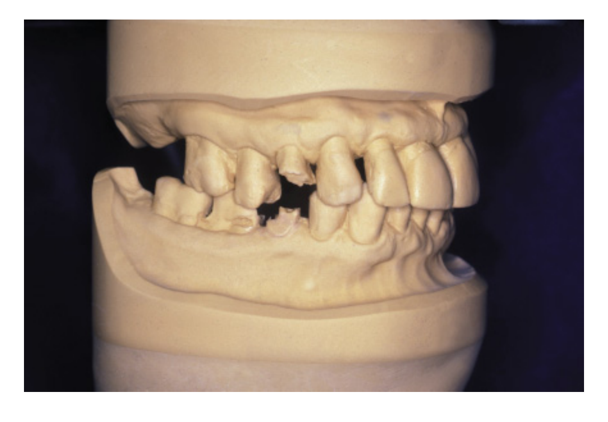


**Figure 8.4.1.** Pretreatment right lateral view of diagnostic casts mounted in maximum intercuspation.



**Figure 8.4.3.** Pretreatment intraoral view of patient with multiple missing teeth, severe generalized periodontitis, recurrent caries, fractured teeth and restorations, and defective anterior FPD.



**Figure 8.4.2.** Pretreatment left lateral view of diagnostic casts mounted in maximum intercuspation.



**Figure 8.4.4.** Postoperaive intraoral view of patient with maxillary complete overdenture and mandibular bilateral distal-extension removable partial overdenture.



**Figure 8.4.5.** Pretreatment right lateral view of patient in maximum intercuspation.



**Figure 8.4.7.** Pretreatment left lateral view of patient in maximum intercuspation.



**Figure 8.4.6.** Posttreatment right lateral view of patient with maxillary complete overdenture and survey crown no. 29 to help retain and support mandibular removable partial overdenture.



**Figure 8.4.8.** Posttreatment left lateral view of patient in maximum intercuspation. Disto-occlusal rest and 19-gauge round wire clasp on tooth no. 21 support and retain left side of mandibular removable partial overdenture.



**Figure 8.4.9.** Pretreatment maxillary occlusal view of patient with severely compromised dentition.



**Figure 8.4.11.** Pretreatment mandibular occlusal view of patient with fractured teeth and defective restorations.



**Figure 8.4.10.** Maxillary occlusal view of patient after extraction of hopeless teeth and endodontic treatment nos. 4, 6, 10, and 13 as complete overdenture abutments.



**Figure 8.4.12.** Mandibular occlusal view of patient after extraction of hopeless teeth and roots and endodontic treatment nos. 18, 30, and 31 as partial overdenture abutments.



**Figure 8.4.13.** Mandibular teeth nos. 18, 30, and 31 prepared as abutments and survey crown no. 29 cemented to help retain and support mandibular removable partial overdenture.



**Figure 8.4.15.** Intraoral view of patient after healing of maxillary residual ridges.

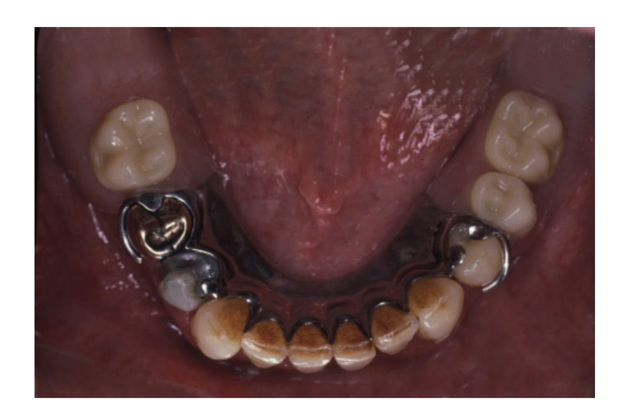


**Figure 8.4.14.** Posttreatment occlusal view of mandibular removable partial overdenture with disto-occlusal rests and 19-gauge round clasps nos. 21 and 29.



**Figure 8.4.16.** Interim acrylic resin RPD worn by patient after extraction of nonrestorable maxillary teeth. Interim RPD used to establish and maintain occlusal vertical dimension.



**Figure 8.4.17.** Maxillary immediate complete overdenture final impression using custom impression tray with polysulfide material for posterior region and metal rim-lock tray and alginate material for anterior region and abutment teeth.



**Figure 8.4.19.** Maxillary and mandibular abutment teeth prepared for insertion of maxillary complete immediate overdenture and mandibular partial overdenture.



**Figure 8.4.18.** Alginate final impression made to provide master cast to fabricate mandibular removable partial overdenture.



**Figure 8.4.20.** Posttreatment intraoral view of maxillary complete overdenture opposing mandibular bilateral distal-extension removable partial overdenture.

## 8.5 Clinical patient scenario #5: maxillary Class III RPD and mandibular Class III RPD

Maxillary and mandibular tooth-borne removable partial dentures accommodate periodontal and esthetically compromised natural dentition. Severely malpositioned anterior teeth are replaced with maxillary and mandibular removable partial dentures.

A 49-year-old Caucasian female was referred for prosthodontic evaluation. The patient's past dental history revealed a treatment course for periodontal problems, extraction of teeth, and amalgam restorations.

The patient's chief complaint was to restore several defective restorations and replace missing teeth recommended for removal by a periodontist. The diagnoses for the patient were based on multidisciplinary consults and included severe generalized periodontitis, defective amalgam restorations, severe horizontal discrepancy with splayed and crowded maxillary and mandibular anterior teeth, and partially edentulous maxillary and mandibular arches.

Diagnostic impressions were made of the patient's maxillary and mandibular arches, and the diagnostic casts were mounted in a semiadjustable articulator. Preliminary treatment to address periodontal hopeless and severely malpositioned teeth was approved by the patient and included extraction of nos. 7, 8, 9, 10, 14, 20, 21, 23–26, and 29 and insertion of maxillary and mandibular acrylic resin interim removable partial dentures.

The treatment plan for this patient consisted of soft-tissue management for localized periodontitis, amalgam restorations nos. 13 and 30, limited orthodontic treatment to correct labioversion no. 28, and maxillary and mandibular tooth-borne removable partial dentures (Figures 8.5.1–8.5.12).



**Figure 8.5.1.** Pretreatment intraoral view of patient with teeth in maximum intercuspation.

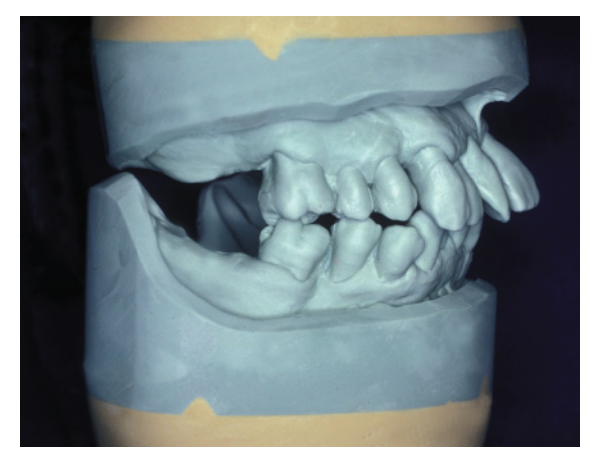


**Figure 8.5.3.** Pretreatment right lateral view of diagnostic casts mounted in maximum intercuspation.



**Figure 8.5.2.** Pretreatment intraoral view of patient with teeth in protrusive position.



**Figure 8.5.4.** Posttreatment right lateral view of patient with maxillary and mandibular tooth-borne removable partial dentures.

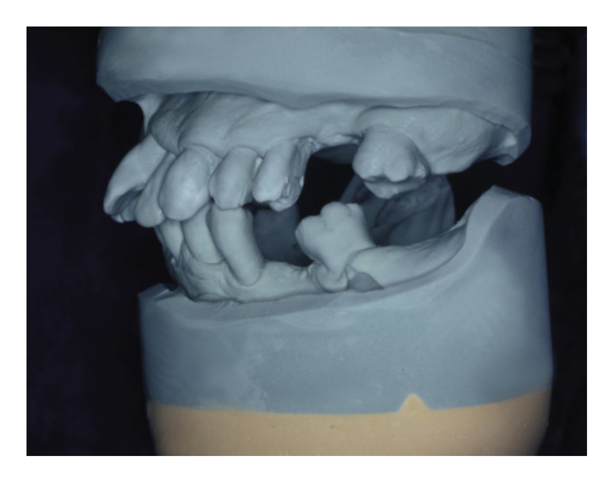


**Figure 8.5.5.** Pretreatment left lateral view of diagnostic casts mounted in maximum intercuspation.

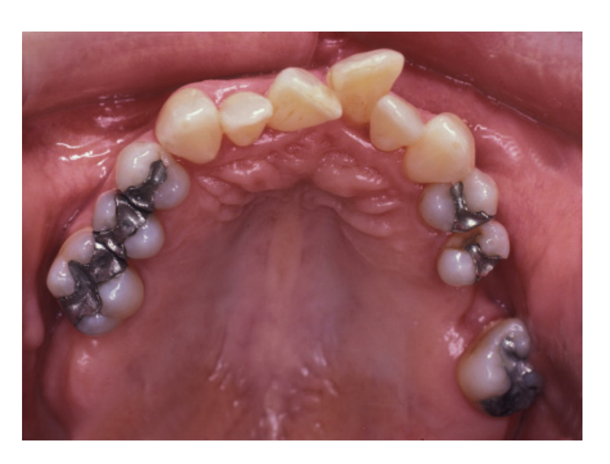


**Figure 8.5.7.** Pretreatment occlusal view of patient with malpositioned maxillary anterior teeth.



**Figure 8.5.6.** Posttreatment left lateral view of patient wearing maxillary and mandibular RPDs.



**Figure 8.5.8.** Posttreatment occlusal view of patient wearing maxillary tooth-borne RPD.



**Figure 8.5.9.** Pretreatment occlusal view of patient showing malpositioned mandibular teeth.



**Figure 8.5.10.** Posttreatment occlusal view of patient wearing tooth-borne mandibular RPD after orthodontic repositioning of tooth no. 28 and extraction of tooth no. 21.



**Figure 8.5.11.** Intraoral frontal view of patient with healed residual ridges after extraction of hopeless teeth. Orthodontic bracket on no. 28 was used for lingual repositioning of tooth.



**Figure 8.5.12.** Posttreatment intraoral view of patient with teeth in maximum intercuspation wearing maxillary and mandibular tooth-borne RPDs.

## 8.6 Clinical patient scenario #6: maxillary Class II RPD and mandibular Class IV rotational path RPD

Maxillary tooth-borne removable partial denture opposes mandibular rotational path removable partial denture. Survey crown and mandibular removable partial denture provide esthetic and functional replacement for long-span anterior fixed partial denture and strategic abutment teeth.

A 69-year-old Caucasian male was evaluated for prosthodontic treatment subsequent to removal of teeth. The patient's past dental history revealed a treatment course for periodontal problems, extraction of teeth, amalgam and composite resin restorations, and a mandibular anterior fixed partial denture.

The patient's chief complaint was to replace missing teeth and the fixed partial denture removed by another dentist. The diagnoses for the patient included caries on tooth nos. 5, 6, and 19 with a carious pulp exposure no. 5, moderate generalized gingivitis, truncated incisal no. 27 due to the loss of a fixed partial denture nos. 22–27, and partially edentulous maxillary and mandibular arches.

Diagnostic impressions were made of the patient's maxillary and mandibular arches, and the diagnostic casts were mounted in a semiadjustable articulator. The maxillary and mandibular casts were surveyed and color-coded designs were drawn on the casts. A rotational path mandibular removable partial denture was designed for the Kennedy Class IV arch configuration due to the long span of the edentulous arch space and the esthetic demands of the patient after loss of the fixed partial denture. Although informed of alternative treatment options, the patient did not select implant therapy for restoration of the mandibular edentulous space.

The treatment plan for this patient consisted of adult prophylaxis and oral hygiene instruction, endodontic treatment no. 5, partial veneer gold survey crown no. 5, metal-ceramic survey crown no. 27, recontoured nos. 8, 9, and 11, and maxillary tooth-borne and mandibular rotational path removable partial dentures (Figures 8.6.1–8.6.14).



**Figure 8.6.1.** Pretreatment intraoral view of maxillary Class II and mandibular Class IV partially edentulous patient in maximum intercuspation position with fractured abutment tooth no. 27.



**Figure 8.6.2.** Posttreatment intraoral view of patient with maxillary tooth-borne and mandibular rotational path removable partial dentures.



**Figure 8.6.3.** Pretreatment right lateral view of patient in maximum intercuspation.



**Figure 8.6.4.** Posttreatment right lateral view of patient with survey crowns nos. 5 and 27 helping to support and retain maxillary and mandibular RPDs.



**Figure 8.6.5.** Pretreatment left lateral view of patient in maximum intercuspation.



**Figure 8.6.6.** Posttreatment left lateral view of patient with 19-gauge round clasp on no. 12 for Class II unilateral distal-extension RPD and 1/2 round clasp on no. 19 for Class IV anterior-to-posterior rotational path RPD.

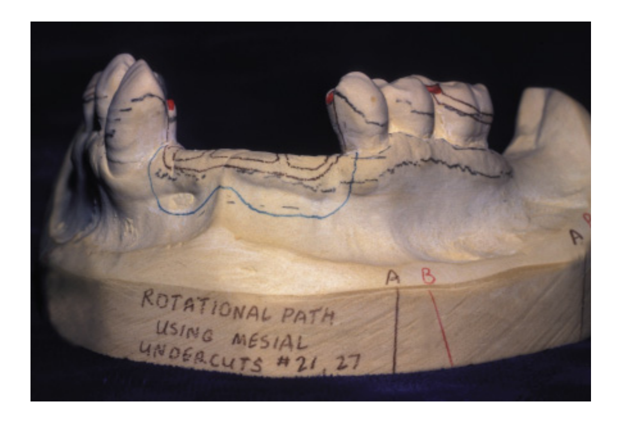



**Figure 8.6.7.** Color-coded design drawn on the diagnostic cast serves as a "blueprint" for intraoral tooth preparation and laboratory fabrication of a mandibular rotational path RPD.




**Figure 8.6.8.** The two tilts necessary to establish dual paths of insertion for an anterior-posterior rotational path mandibular RPD are marked in contrasting colored lines on the diagnostic cast.



**Figure 8.6.9.** The two sets of tripod marks help determine the exact tilt to position the casts for design and fabrication of the anterior-posterior rotational path mandibular RPD.

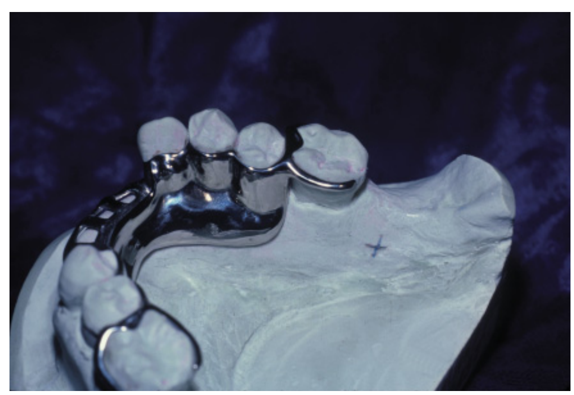


**Figure 8.6.10.** Lingual view of completed metal framework for rotational path mandibular RPD seated on the master cast.



**Figure 8.6.11.** Occlusal view of partially edentulous maxillary arch with 3/4 gold survey crown cemented on tooth no. 5.



**Figure 8.6.13.** Mandibular rotational path metal framework seated on master cast. Retention is from metal engaging mesial undercuts in anterior region and from circlet clasps engaging distobuccal undercuts bilaterally in posterior regions.

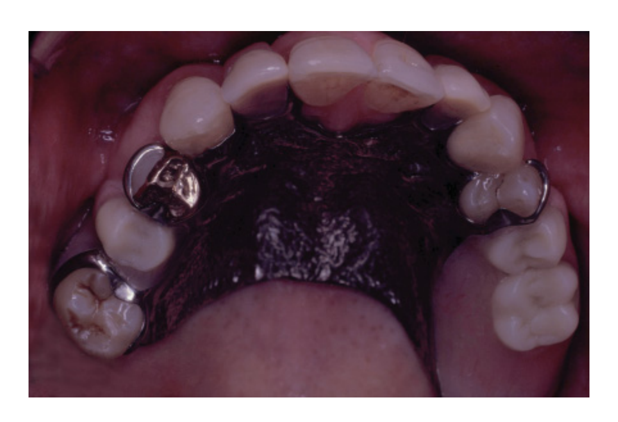


**Figure 8.6.12.** Occlusal view of maxillary Class II RPD with disto-occlusal rest and 19-gauge round clasp on tooth no. 12 for support and retention of the unilateral distal-extension denture base and metal framework.



**Figure 8.6.14.** Posttreatment occlusal view of mandibular Class IV rotational path RPD with cingulum rest no. 27 and mesio-occlusal rests on nos. 19, 21, and 30.

## 8.7 Clinical patient scenario #7: mandibular Class I removable partial overdenture with cast metal dowel and coping abutments

Endodontic and periodontal treatment and patient concerns dictate design of a mandibular removable partial to accommodate a guarded prognosis for abutment teeth. Cast metal dowel and copings provide support for mandibular bilateral distal-extension removable partial denture.

A 65-year-old Caucasian female was evaluated for prosthodontic treatment after endodontic and surgical periodontal therapy. The patient's past dental history revealed a treatment course for moderate to severe generalized periodontal disease, extraction of teeth, amalgam restorations, single crowns, myofascial pain, and endodontic therapy.

The patient's chief complaint was to follow the endodontic and periodontal treatment with replacement of missing teeth and restoration of a fractured crown. The diagnoses for the patient included fractured all-ceramic crown no. 8, endodontic treatment nos. 19 and 31 with hemisection no. 19 and distal root removal, isolated moderate periodontitis and +1 mobility for nos. 12, 13, 20, and 31, defective restoration no. 13, nocturnal bruxism, and partially edentulous maxillary and mandibular arches.

Diagnostic impressions were made of the patient's maxillary and mandibular arches, and the diagnostic casts were mounted in a semiadjustable articulator. The prosthodontic treatment planned was dictated by previous endodontic and periodontal treatments and the patient's strong desire to retain all of her remaining teeth. A guarded prognosis for the dental treatment was given to the patient.

The prosthodontic treatment plan for this patient consisted of a cast metal dowel and copings nos. 19 and 31, metal-ceramic crown no. 8, amalgam restoration no. 13, mandibular bilateral distal-extension removable partial overdenture, and a maxillary occlusal splint. After prosthodontic treatment, the patient was referred for periodontal reevaluation and follow-up care (Figures 8.7.1–8.7.11).



**Figure 8.7.1.** Pretreatment intraoral view of patient with multiple missing teeth, guarded periodontal prognosis, and myofascial pain due to nocturnal bruxism.



**Figure 8.7.3.** Pretreatment right lateral view of patient in maximum intercuspation.



**Figure 8.7.2.** Posttreatment intraoral view of patient in maximum intercuspation with new metal-ceramic crown no. 8 and mandibular bilateral distal-extension partial overdenture.



**Figure 8.7.4.** Posttreatment right lateral view of patient with mandibular partial overdenture supported and retained on the right side by disto-occlusal rest and 19-gauge round circlet clasp.



**Figure 8.7.5.** Pretreatment left lateral view of patient in maximum intercuspation with endodontic treated and hemi-sectioned tooth no. 19. Tooth no. 20 has +1 mobility and a guarded periodontal prognosis.



**Figure 8.7.6.** Posttreatment left lateral view of patient with mandibular partial overdenture supported and retained on the left side by mesio-occlusal rest and 1/2 round reverse circlet clasp on tooth no. 21.



**Figure 8.7.7.** Occlusal view of maxillary arch with wide spacing between teeth, +1 mobility for teeth nos. 12 and 13, fractured all-ceramic crown no. 8, and defective composite resin and amalgam restorations.



**Figure 8.7.8.** Close-up view of new metal-ceramic crown no. 8 and composite resin replacement restorations nos. 7 and 10.



**Figure 8.7.9.** Occlusal view of mandibular arch with endodontic treated no. 19 and no. 31.



**Figure 8.7.10.** Occlusal view of mandibular arch with cast metal dowel and coping abutments for support of a mandibular bilateral distal-extension removable partial overdenture.



**Figure 8.7.11.** Posttreatment view of mandibular Class 1 removable partial overdenture with the clasp assembly on the patient's left side designed for loss of periodontal compromised tooth no. 21.

## 8.8 Clinical patient scenario #8: full-mouth reconstruction with mandibular Class III RPD

Full-mouth reconstruction incorporates mandibular tooth-borne removable partial denture design with I-bar clasps for retention and lab-processed composite resin for tooth replacements. Long-span posterior edentulous space and tipped abutment teeth are managed with survey crowns and a mandibular removable partial denture.

A 58-year-old Caucasian female was referred for evaluation for a complete-mouth reconstruction after having several large amalgam restorations placed by a general dentist. The patient's past dental history revealed a treatment course for widespread caries and recurrent caries that included extraction of teeth, amalgam and composite resin restorations, and single crowns.

The patient's chief complaint was to replace missing teeth and defective crowns with highly esthetic fixed restorations. The diagnoses for the patient included recurrent caries, defective amalgam and composite resin restorations on many teeth, defective and unesthetic single crowns, irreversible pulpitis no. 12, and a partially edentulous mandibular arch.

Diagnostic impressions were made of the patient's maxillary and mandibular arches, and the diagnostic casts were mounted in a semiadjustable articulator. A diagnostic wax-up confirmed that a mutually protected occlusion could be achieved. The long edentulous span and tipped abutment teeth in the mandibular posterior edentulous spaces contraindicated fixed partial dentures. The patient did not desire surgical placement and restoration of implants in the edentulous spaces.

The treatment plan for this patient consisted of endodontic treatment no. 12, composite resin and amalgam foundation restorations, single crowns on all remaining maxillary and mandibular teeth with surveyed crowns on nos. 17, 20, 29, and 31, and a mandibular removable partial denture with I-bar clasps for retention, and lab-processed tooth-colored composite resin for replacement of missing mandibular teeth (Figures 8.8.1–8.8.10).



**Figure 8.8.1.** Pretreatment intraoral view of patient shows multiple missing mandibular teeth, defective restorations, and unesthetic crowns.



**Figure 8.8.2.** Intraoral view of patient with full-mouth reconstruction using metal-ceramic survey crowns to help retain and support a mandibular tooth-borne removable partial denture.



**Figure 8.8.3.** Mandibular RPD with I-bar retentive clasps and lab-processed composite resin replacement teeth is designed to meet the esthetic and functional demands of the patient.



**Figure 8.8.4.** Posttreatment intraoral frontal view of the mandibular Class III RPD seated in the patient's mouth.



**Figure 8.8.5.** Occlusal view of maxillary arch reconstruction with metal-ceramic crowns cemented on teeth nos. 2–15.



**Figure 8.8.6.** Occlusal view of mandibular arch reconstruction and Class III RPD seated in the patient's mouth.



**Figure 8.8.7.** Right lateral view of full-mouth reconstruction designed with metal-ceramic survey crowns nos. 29 and 31 for retention and support of right side of mandibular tooth-borne RPD.



**Figure 8.8.8.** Left lateral view of survey crowns on teeth nos. 17 and 21 placed instead of FPD due to the long span of the edentulous space and tipped abutment tooth no. 17.



**Figure 8.8.9.** Pretreatment frontal view of patient confirms unesthetic crowns, discolored anterior teeth, and an asymmetric smile line that contributed to patient's chief complaint.



**Figure 8.8.10.** Posttreatment frontal view of patient with full-mouth reconstruction using metal-ceramic crowns and a mandibular Class III RPD to meet esthetic and functional challenges.

## 8.9 Clinical patient scenario #9: maxillary complete denture and mandibular Class I RPD

Unstable and nonfunctional acrylic resin mandibular removable partial denture opposes an unesthetic maxillary complete denture. A mandibular bilateral distal-extension removable partial denture with infrabulge 1/2-T clasps opposing a new maxillary complete denture provides a highly esthetic and stable solution.

A 37-year-old Asian female was referred for prosthodontic evaluation of an ill-fitting mandibular acrylic resin RPD. The patient's past dental history revealed a treatment course including extraction of teeth and wear of an immediate maxillary complete denture and an acrylic resin mandibular RPD with no retentive clasps.

The patient's chief complaint was a desire for replacement of the immediate maxillary complete denture and acrylic resin mandibular RPD due to poor fit, poor esthetics, and loss of mandibular teeth after placement of the prostheses. The diagnoses for the patient included a completely edentulous maxillary arch and a partially edentulous mandibular arch, functionally inadequate posterior occlusion, excessive vertical bone loss of the mandibular posterior residual ridges, and ill-fitting and unesthetic maxillary and mandibular removable prostheses.

Diagnostic impressions were made of the patient's maxillary and mandibular arches. The mandibular cast was surveyed and a color-coded design was drawn on the cast. Although only three mandibular teeth remained, an RPD metal framework was designed with infrabulge 1/2-T retentive clasps for teeth nos. 21 and 29 to improve stability, retention, and esthetics.

The treatment plan for this patient consisted of simultaneous fabrication of a new maxillary complete denture and a definitive mandibular bilateral distal-extension RPD with infrabulge 1/2-T retentive clasps (Figures 8.9.1–8.9.5).



**Figure 8.9.1.** Pretreatment intraoral view of patient with unesthetic maxillary complete denture and ill-fitting mandibular acrylic resin removable partial denture.



**Figure 8.9.2.** Occlusal view of mandibular arch with three abutment teeth and nonretentive acrylic resin RPD.



**Figure 8.9.3.** Extraoral view of patient at wax try-in of maxillary and mandibular prostheses to verify phonetics, esthetics, and function.



**Figure 8.9.4.** Posttreatment intraoral view of patient with a maxillary complete denture and a mandibular bilateral distal-extension RPD retained by infrabulge 1/2-T cast clasps.



**Figure 8.9.5.** Posttreatment left facial view of patient with new maxillary complete denture and mandibular Class I RPD that provide stable, functional, and highly esthetic results.

## 8.10 Clinical patient scenario #10: maxillary complete denture and mandibular Class I acrylic resin RPD with labial wrought wire for orthodontic stabilization

Severely protruding anterior teeth in a partially edentulous mandibular arch oppose an ill-fitting and unesthetic maxillary complete denture. After anterior teeth are repositioned, an acrylic resin mandibular removable partial denture with a labial wrought wire provides a stable occlusal relation for a new maxillary complete denture.

A 43-year-old Asian female was referred for prosthodontic evaluation before removal of her remaining teeth. The patient's past dental history revealed a treatment course including caries, generalized periodontal disease, amalgam restorations, extraction of teeth, and wear of a maxillary complete denture.

The patient's chief complaint was a desire for replacement of the ill-fitting and unesthetic maxillary complete denture and correction of the wide spaces between her mandibular anterior teeth. The diagnoses for the patient included extreme migration and splaying of mandibular anterior teeth, a completely edentulous maxillary arch, a partially edentulous mandibular arch, functionally inadequate Class III occlusion, excessive vertical bone loss of the mandibular posterior left residual ridge, and ill-fitting maxillary removable prosthesis.

Diagnostic impressions were made of the patient's maxillary and mandibular arches and the existing complete denture. The mandibular and maxillary denture casts were used to analyze the maxillomandibular relations. A consult with an orthodontist determined that the wide spacing in the mandibular anterior region could be corrected using removable orthodontic appliances while the patient wore the existing maxillary complete denture.

The first phase of treatment consisted of orthodontic movement of the mandibular anterior teeth using removable Hawley appliances with flat posterior occlusal platforms to close all spaces and reposition the mandibular anterior teeth in a Class I relationship. The second phase of treatment consisted of wear of a definitive acrylic resin mandibular RPD with a labial wrought wire opposing a new maxillary complete denture to maintain the newly acquired functional and esthetic relationship (Figures 8.10.1–8.10.14).



**Figure 8.10.1.** Pretreatment intraoral view of patient with unstable maxillary complete denture and severely malpositioned mandibular anterior teeth.



**Figure 8.10.2.** Posttreatment intraoral view of patient with new maxillary complete denture and mandibular acrylic resin RPD.



**Figure 8.10.3.** Pretreatment right lateral view of patient with severely protruding mandibular anterior teeth.

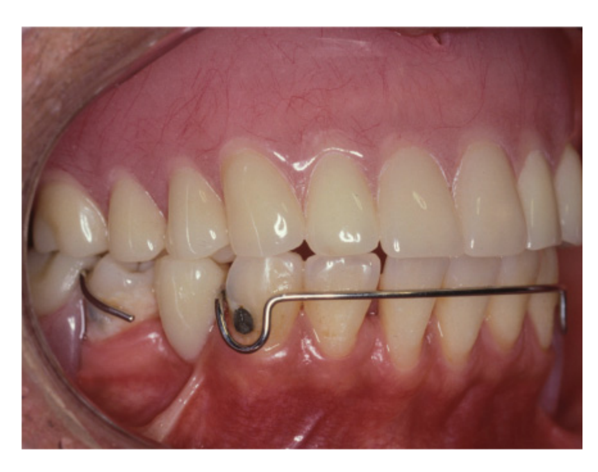


**Figure 8.10.4.** Posttreatment right lateral view of patient with repositioned mandibular anterior teeth retained by mandibular acrylic resin RPD with labial wrought wire.



**Figure 8.10.5.** Pretreatment left lateral view of patient with unstable and inadequate posterior occlusion.

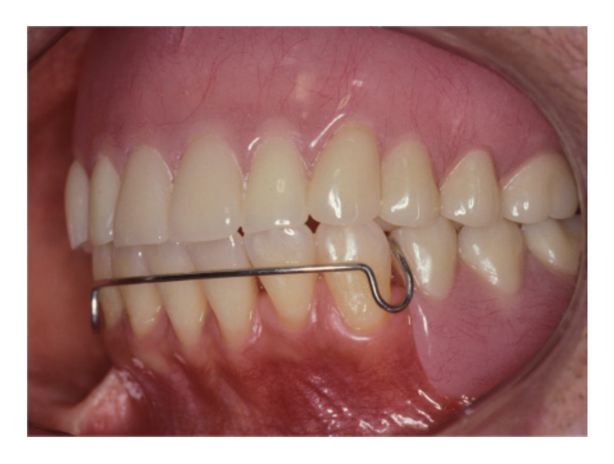


**Figure 8.10.6.** Posttreatment left lateral view of patient with new maxillary complete denture and mandibular acrylic resin RPD providing a stable and functional posterior occlusion.



**Figure 8.10.8.** Occlusal view of mandibular diagnostic cast showing wide spacing between teeth and narrow residual ridges in edentulous areas.



**Figure 8.10.7.** Pretreatment diagnostic casts of patient provided for orthodontic consultation.



**Figure 8.10.9.** Intraoral view of patient wearing a mandibular removable orthodontic appliance designed to reposition the anterior teeth. Clear acrylic resin occlusal platforms on the appliance stabilize maxillomandibular relations with the old complete denture during treatment.



**Figure 8.10.10.** Intraoral view of patient indicating the final position of mandibular anterior teeth after orthodontic repositioning against the patient's old maxillary complete denture.



**Figure 8.10.11.** Maxillary complete denture and mandibular acrylic resin RPD with labial wrought wire after laboratory fabrication.



**Figure 8.10.12.** Extraoral view of patient at time of insertion of new maxillary and mandibular removable prostheses.



**Figure 8.10.13.** Frontal view of patient wearing new maxillary complete denture and mandibular acrylic resin RPD.



**Figure 8.10.14.** Left facial view of patient wearing maxillary complete denture and Class I acrylic resin RPD that provide a stable and esthetic maxillomandibular relationship.

## 8.11 Clinical patient scenario #11: maxillary complete denture and mandibular Class I RPD with composite resin to restore and maintain occlusal vertical dimension

> Maxillary complete denture with porcelain teeth results in severe posterior tooth wear and loss of occlusal vertical dimension. Composite resin bonded to mandibular premolars establishes occlusal stability for a new maxillary complete denture and mandibular bilateral distal-extension removable partial denture.

A 40-year-old Caucasian male was referred for prosthodontic evaluation. The patient's past dental history revealed a treatment course including caries, extraction of teeth, and wear of a maxillary complete denture and a mandibular removable partial denture. The patient had limited financial resources.

The patient's chief complaint was an inability to chew food with the mandibular removable partial denture. The diagnoses for the patient included a completely edentulous maxillary arch, a partially edentulous mandibular arch, severe wear of mandibular premolar facial cusps, a collapsed vertical dimension of occlusion, and functionally inadequate posterior occlusion.

Diagnostic impressions were made of the patient's maxillary and mandibular arches. The multiphase treatment plan for this patient consisted of a new mandibular removable partial denture opposing a new maxillary complete denture with resin denture teeth and restoration of worn premolars with composite resin to reestablish vertical dimension of occlusion.

The first phase of treatment consisted of maxillary and mandibular custom impressions and fabrication of a mandibular removable partial denture metal framework. The second phase consisted of occlusion rims and maxillomandibular records to register the vertical dimension of occlusion of the patient. The third phase consisted of tooth arrangements and trial wax-ups of the maxillary complete denture and mandibular removable partial denture to analyze the wear of the premolar cusps. The fourth phase consisted of insertion of the new prostheses and bonding of composite resin to the worn facial cusps of the mandibular premolars to maintain the occlusal vertical dimension (Figures 8.11.1–8.11.10).



**Figure 8.11.1.** Pretreatment intraoral view of patient with limited financial resources who complains of inability to chew food with maxillary complete denture and mandibular removable partial denture.



**Figure 8.11.3.** Pretreatment left lateral view of patient with porcelain denture teeth on maxillary complete denture and heavily worn posterior plastic denture teeth on mandibular RPD.



**Figure 8.11.2.** Posttreatment intraoral view of patient with a new maxillary complete denture and mandibular RPD that restore stability, function, and esthetics.



**Figure 8.11.4.** Pretreatment left lateral view of patient with severe wear of facial cusps on mandibular left premolars.



**Figure 8.11.5.** Left lateral view of trial wax-up of maxillary and mandibular removable prostheses with reoriented occlusal plane and corrected occlusal vertical dimension.



**Figure 8.11.6.** Posttreatment left lateral view of patient with composite resin restored premolars in maximum intercuspation with posterior plastic teeth on new maxillary complete denture.



**Figure 8.11.7.** Right lateral view of trial wax-up of maxillary complete denture and mandibular Class I RPD that helps determine restoration of the premolar facial cusp.



**Figure 8.11.8.** Posttreatment right lateral view of patient with composite resin restored premolar providing support and retention for the right side of Class I bilateral distal-extension RPD.



**Figure 8.11.9.** Pretreatment extraoral view of patient with loss of occlusal vertical dimension due to severe wear of mandibular natural and prosthetic posterior teeth.



**Figure 8.11.10.** Posttreatment extraoral view of patient with new maxillary complete denture and mandibular bilateral distal-extension RPD to reestablish appropriate maxilloman-dibular relations and improve mastication.

## 8.12 Clinical patient scenario #12: maxillary immediate complete denture and mandibular Class I RPD with composite resin for facial surfaces and cingulum rest seats

Maxillary immediate complete denture opposes a mandibular bilateral distal-extension removable partial denture. Composite resin bonded to the lingual and facial surfaces of abutment teeth provides rest seats and retentive contours for the mandibular removable partial denture designed with cingulum rests and I-bar clasps.

A 32-year-old Caucasian female was referred for prosthodontic evaluation before removal of her remaining teeth. The patient's past dental history revealed a treatment course including caries and extraction of teeth. The patient had financial constraints that eliminated extensive restorative treatment of the maxillary teeth.

The patient's chief complaint was a desire for removal of her remaining teeth and replacement of missing teeth with immediate dentures. The diagnoses for the patient included severe caries on the remaining maxillary teeth, a carious pulp exposure no. 6, partially edentulous maxillary and mandibular arches, and excessive vertical bone loss of the mandibular posterior residual ridges.

Diagnostic impressions were made of the patient's maxillary and mandibular arches. The multiphase treatment plan included a maxillary immediate complete denture and a mandibular bilateral distal-extension removable partial denture with modification of existing abutment teeth with composite resin to improve retention and enhance support of the mandibular prosthesis.

The first phase of treatment consisted of modification of the facial surfaces of nos. 23 and 27 with bonded composite resin to provide 0.010″ retentive undercuts for I-bar clasp placement and modification of the lingual surfaces nos. 23 and 27 with bonded composite resin to provide cingulum rest seats for vertical support of the removable partial denture metal framework. The second phase of treatment consisted of fabrication of a maxillary complete denture and mandibular bilateral distal-extension removable partial denture. The third phase of treatment consisted of extraction of nos. 6, 9, 10, 11, and 14 and the simultaneous insertion of the maxillary and mandibular removable prostheses (Figures 8.12.1–8.12.7).



**Figure 8.12.1.** Pretreatment view of patient with severe caries on remaining maxillary teeth and multiple missing mandibular teeth.



**Figure 8.12.3.** Lingual and incisal surfaces of mandibular anterior teeth lacking vertical support features for a bilateral distal-extension RPD.



**Figure 8.12.2.** Close-up view of patient's mandibular anterior teeth with facial surfaces unable to provide usable undercuts for RPD clasp retention.



**Figure 8.12.4.** Lingual surfaces of mandibular lateral incisor and canine modified with bonded composite resin cingulum rest seats to enhance support for RPD.

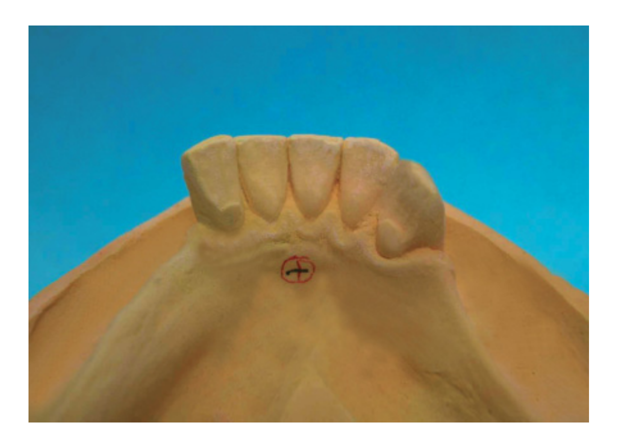


**Figure 8.12.5.** Lingual view of master cast for laboratory fabrication of mandibular RPD metal framework showing composite resin rest seats.



**Figure 8.12.7.** Posttreatment view of patient with maxillary immediate complete denture and mandibular bilateral distal-extension RPD.

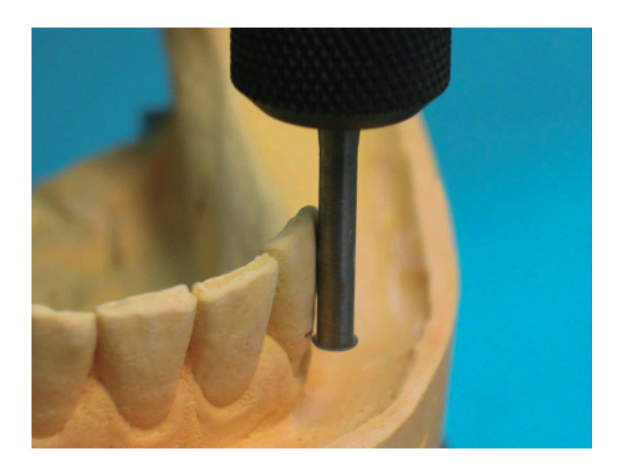


**Figure 8.12.6.** Survey of lateral incisor abutment tooth on master cast after modification with composite resin to obtain 0.010″ midfacial undercut for I-bar clasp retention.

## 8.13 Clinical patient scenario #13: full-mouth reconstruction with mandibular Class II RPD

Bruxism and acidic insult to natural teeth result in the erosion of enamel and a fractured tooth. Full-mouth reconstruction incorporates fixed partial dentures and single crowns in the maxillary arch opposing surveyed crowns and a unilateral removable partial denture in the mandibular arch.

A 45-year-old Caucasian female was referred for prosthodontic evaluation of a fractured tooth and severe wear on her remaining teeth. The patient's past dental history revealed a treatment course for fractured teeth and recurrent caries that included extraction of teeth, amalgam and composite resin restorations, and single crowns.

The patient's chief complaint was to replace a fractured tooth and unesthetic restorations and improve her smile. The diagnoses for the patient included severe tooth wear due to anorexia and bruxism, recurrent caries, defective amalgam and composite resin restorations, defective and unesthetic single crown and fixed partial denture, a nonrestorable maxillary molar due to a cusp/root fracture, and partially edentulous maxillary and mandibular arches.

Diagnostic impressions were made of the patient's maxillary and mandibular arches, and the diagnostic casts were mounted in a semiadjustable articulator. A diagnostic wax-up confirmed that a mutually protected occlusion could be achieved. The severe tooth wear had resulted in short and unesthetic clinical crown lengths on the patient's maxillary anterior teeth. The patient was advised that removal of tooth no. 3 and periodontal crown lengthening of the maxillary anterior teeth were needed before full-mouth prosthodontic reconstruction.

The treatment plan for this patient consisted of referral to a psychologist for evaluation and counseling, extraction no. 3, periodontal surgical treatment in the maxillary anterior region, composite resin and amalgam foundation restorations, fixed partial dentures to replace nos. 3, 4, and 14, single crowns on all remaining maxillary and mandibular teeth with surveyed crowns on nos. 18, 19, 21, 28, and 29, and a mandibular unilateral distal-extension removable partial denture (Figures 8.13.1–8.13.12).



**Figure 8.13.1.** Pretreatment intraoral view of patient with severe wear of natural dentition and unesthetic restorations and crown lengths in the maxillary anterior region.



**Figure 8.13.2.** Postsurgical intraoral view of patient showing crown-lengthened maxillary anterior teeth.



**Figure 8.13.3.** Maxillary occlusal view of patient with erosion of lingual surfaces of anterior teeth due to acidic insult and fractured first molar and defective restorations.



**Figure 8.13.4.** Mandibular occlusal view of patient with missing right molars and severe wear of teeth due to bruxism.

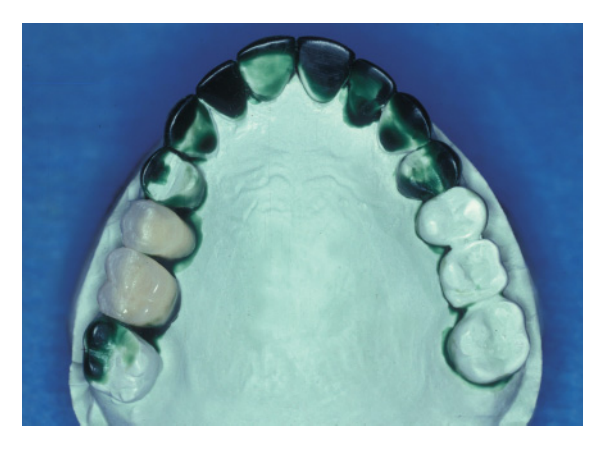


**Figure 8.13.5.** Occlusal view of diagnostic wax-up of maxillary reconstruction with bilateral fixed partial dentures nos. 2–5 and nos. 13–15. Tooth no. 3 has been treatment planned for extraction.



**Figure 8.13.7.** Right lateral view of diagnostic wax-up for full-mouth reconstruction with 1/2-T infrabulge clasp designed to retain right side of mandibular unilateral distal-extension RPD.

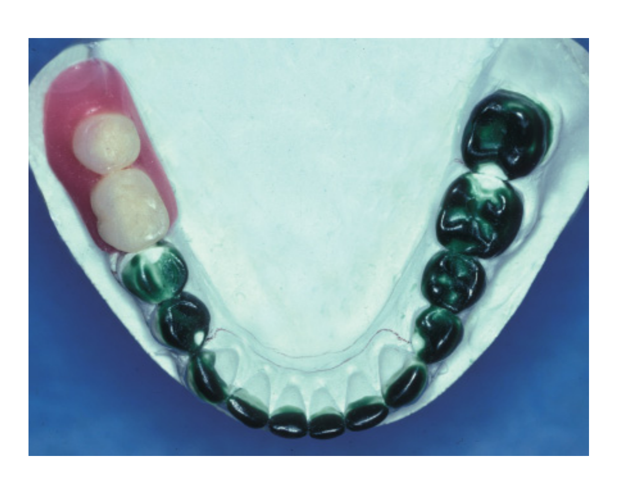


**Figure 8.13.6.** Occlusal view of diagnostic wax-up of mandibular reconstruction with survey crowns nos. 18, 19, 21, 28, and 29 designed for a Class I unilateral distal-extension RPD.



**Figure 8.13.8.** Pretreatment frontal view of diagnostic wax-up for full-mouth reconstruction showing short clinical crown lengths on maxillary anterior teeth.



**Figure 8.13.9.** Postsurgical intraoral view of patient with natural dentition in maximum intercuspation.



**Figure 8.13.10.** Posttreatment intraoral view of patient after full-mouth reconstruction with maxillary crowns, maxillary fixed partial dentures, mandibular survey crowns, and mandibular unilateral RPD.



**Figure 8.13.11.** Pretreatment extraoral view of patient before periodontal crown lengthening of maxillary anterior teeth.



**Figure 8.13.12.** Posttreatment extraoral view of patient after full-mouth reconstruction.

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